



Joseph Moxon.  
Born at Wakefeild August 8.  
Anno 1627.

# A TUTOR TO Astronomy and Geography. Or an easie and speedy way to know the USE of both the **GLOBES,** *Cælestial and Terrestrial.*

In SIX BOOKS.

- The {  
1. Teaching the Rudiments of *Astronomy* and *Geography*.  
2. Shewing { *Astronomical* and *Geographical* Problemes.  
3. by the { *Problemes in Navigation*.  
4. GLOBES { *Astrological* Problemes.  
5. the soluti- { *Gnomonical* Problemes.  
6. on of { *Trigonometrical* Problemes.

More fully and amply than hath yet been set forth, either by *Gemna Frisius, Metius, Hues, Wright, Blaew*, or any others that have taught the Use of the GLOBES: And that so Plainly and Methodically, that the meanest Capacity may at first Reading apprehend it, and with a little Practice grow expert in these Divine Sciences.

With an APPENDIX shewing the Use of the *Ptolemaick Sphere*.

The Fourth Edition Corrected and Enlarged.

By JOSEPH MOXON.

Whereunto is added the *Antient Poetical Stories of the Stars*: shewing Reasons why the several Shapes and Forms are pictured on the *Cælestial Globe*.

As also a Discourse of the *Antiquity, Progress and Augmentation of Astronomy*.

Job XXVI. 7. 13.

He stretcheth out the North over the empty place, and hangeth the Earth upon nothing.  
By his Spirit he hath garnished the Heavens: His hand hath framed the crooked Serpent.

L O N D O N.

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Ludgate Street, at the sign of *Atlas*. 1686.

TO THE  
RIGHT HONOURABLE,  
**ROGER,**  
EARL of CASTLEMAIN.

*My Lord,*



*Our Lordships ample comprehension of the Sphere in all its Constitutions is so sufficiently shewn in your most excellent Invention of the English Globe, and the many Ingenions and Novel Uses you apply it to, in your accurate Book of its Use, that I should discover an unpardonable ignorance to present a Book with this Title to your Lordship, as Such. Therefore, Pray my Lord, do not think I do:*  
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But in this Fourth Impression I take the opportunity, as well to shew my humble Respects to your Lordship, as to let your Lordship see that your Lordship is Author of an Addition to it; and therefore will, I hope, accept this Dedication: for by your Lordships directions I have supplied the deficiency, your Lordship well might wonder at, in your Book of the Use of the English Globe.

My Lord,

I am

Your Lordships

most Humble and Obedient

Servant,

Joseph Moxon.

## To the Reader.

Courteous Reader.

**T**He Globes is the first Study a Learner ought to undertake, for without a competent apprehension of them he will not be able to understand any Author either in Astronomy, Astrology, Navigation, or Trigonometry: Therefore my aim in this Book hath been to make the Use of them very plain, and easie to the meanest Capacities: In prosecution of which Design, I doubt the Learnedest sort may be apt to Censure me guilty of Prolixity, if not Tautology: Because the precepts being plain, they may account some of the Examples Useless. But I desire them to consider, that I write not to expert Practitioners, but to Learners; to whom Examples may prove more Instructive than Precepts. Besides, I hope to encourage those by an ample liberal plainness to fall in love with the Studies, that formerly have been disheartened by the Crabbed brevity of those Authors that have (in Characters as it were rather writ Notes for their own Memories, than sufficient Documents for their Readers Instructions.

The Globes for which this Book is written are new Globes that I set forth, which as I told you in my Epistle to the Reader of Blaws Book differs somewhat from other Globes; and that both the Coelestial and the Terrestrial; mine being the latest done of any, and to the accomplishing of which I have not only had the help of all or most of the best of other Globes, Maps, Platts, and Sea-drafts of New discoveries that were then extant for the Terrestrial Globe, but also the Advice and directions of divers able Mathematicians both in England and Holland for Tables and Calculations both of Lines and Stars for the Coelestial: upon which Globe I have placed every Star that was observed by Tycho Brahe and other Observers, one degree of Longitude farther in the Ecliptick than they are on any other Globes: so that whereas on other Globes the places of the Stars were correspondent with their places in Heaven 69 Years ago, when Tycho observed them, and therefore according to his Rule want almost a degree of their true places in Heaven at this Time: I have set every Star one degree farther in the Ecliptick, and rectified them on the Globe according to the true place they had in Heaven in the Year 1671.

On the Terrestrial Globe I have inserted all the New Discoveries that have been made, either by our own or Forraign Navigators, and that both in the East, West, North and South parts of the Earth. In the East Indies we have in these latter Times many spacious places discovered, many Islands inserted, and generally the whole Draught of the Country rectified and amended, even to the Coast of China, Japan, Giloli, &c. In the South Sea between the East and West Indies are scattered many Islands, which for the uncertain knowledge former Times had of them are either wholly left out of other Globes, or else laid down so erroneously that little of credit can be attributed unto them. California is found to be an Island; though formerly supposed to be part of the main Continent, whose North-West-shore was imagined to thrust it self forth close to the Coasts of Cathaio, and so make the supposed Straights of Anian. The Western Shoars of the West Indies are more accurately described than formerly, as you may see if you compare my Terrestrial Globe: that I have lately set forth with the Journals of the latest Navigators: And if you compare them with other Globes you will find 5, 6, yea 7 degrees difference

in Longitude in most Places of these Coasts. Magellanica which heretofore was thought to be part of the South Continent called Terra Incognita is now also found to be an Island. All that Tract of Land called Terra Incognita I have purposely omitted, because as yet we have no certainty whether it be Sea or Land; unless it be of some parts lately found out by the Dutch; who having a convenient Port at Batavia in Java, have from thence sent forth Ships Southwards, where they have found several very large countries; one whereof they have called Hollandia Nova, another Zelandia Nova, another Anthoni van Diemens Land, and divers others, some whereof lie near our Antipodes; as you may see by my Terrestrial Globe. Again, Far to the Northwards there are some New Discoveries, even within six degrees of the Pole: The Drafts to the North Eastwards I have laid down even as they were described by the Searchers of those parts for a passage into the East Indies. And also the Discoveries of Bassin, Captain James, and Capt. Fox (our own Country-men) that attempted the finding a passage that way into the South Sea.

I also told you what difference there is in several Authors about placing the first Meridian, which is the beginning of Longitude; that Ptolomy placed it at the Fortunate Islands, which Mr. Hues pag 4. chap. 1. in his Treatise of Globes proves to be the Islands of Cabo Verde, and not those now called the Canary Islands; because in his Time they were the farthest place of the Discovered World towards the setting of the Sun: Others placed it at Pico in Teneriffa; Others at Corvus and Flora; because under that Meridian the Compass had no Variation, but did then duly respect the North and South; Others for the same Reason began their Longitude at St. Michaels; and Others between the Islands of Flores and Fayal: And the Spaniards of late by reason of their great Negotiation in the West Indies, have begun their Longitude at Toledo there, and contrary to all others account it Westwards.

Therefore I seeing such diversity among all Nations, and as yet an Uniformity at home, chose with our own Country-men to place my First Meridian at the Ile Gratiola, one of the Isles of Azores.

By the different placing of this first Meridian it comes to pass that the Longitude of places are diversly set down in different Tables; For those Globes or Maps that have their first Meridian placed to the Eastwards of Gratiola, have all places counted Eastwards between the first Meridian and the Meridian of Gratiola in fewer degrees of Longitude: And those Globes and Maps that have their first Meridian placed to the Westwards, have all places counted Eastwards from the Meridian of Gratiola, and their first Meridian in a greater number of degrees of Longitude, and that according as the Arch of Difference is.

As an Appendix to this Book I have added a description of the Ptolomaick Spheres, and have inserted some particular Problemes of its use: together with Instructions how the whole use of that Sphere may easily be known by this Book.

I have also annexed a small Collection out of Dr. Hood, which declares the Reasons why such strange Figures and Forms are pictured on the Celestial Globes: and withal the Poetical Stories of every Constellation.

I likewise thought good to add at the latter end of this Book, a small Treatise, intituled The Antiquity, Progress, and Augmentation of Astronomy. I may without partiality give it the Encomium of a Pithy, Pleasant, and Methodical piece: It was written by Gallendus, and is worthy the Perusal of all Ingenious Lovers of the Studies.

Joseph Moxon;

# The First BOOK.

Being the first Rudiments of

## Astronomy and Geography.

OR, A

Description of the Lines, Circles, and other Parts of the

## GLOBES.

### P R Æ F A C E.

**T**He Students of all Arts and Sciences have ever proposed a Maxim, whereon (as on an allowed Truth) the whole Science hath dependance: and by so much the more demonstrable that Maxim is, so much the more of Excellency the Science may claim.

This of Astronomy and Geography comes not behind any; for herein we shall only admit (with the Ancients) that the Form of the visible World is Spherical: Neither shall we beg our Assertion any further than Ocular Appearance will demonstrate: every Mans Eye being his Judge, if he be either on a Plain field, or at Sea, where nothing can hinder a free inspection of the Horizon.

Upon good grounds therefore, they asserted the Spherical form of the Whole: and also concluded the Parts to be Round: I mean, every intire Subsistence, as the Stars, Planets, and the Earth. In the Celestial Bodies (as the Stars and Planets) this is also visible; and therefore uncontrollable: But that the Earth is Round proves with  
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the unskilful, matter of dispute; they frequently objecting with S. Auſline the words of the Scripture, which ſay, He hath ſtretched forth the Corners of the Earth; not conſidering whether thoſe words were ſpoken as alluding to the amplitude of Gods Omnipotence, or that the Corners were meant Capes of Land, which indeed are ſtretched forth into the Sea. But that the Earth is Round is proved by divers certain and infallible Reaſons.

As firſt, By the Navigations of our Age, Divers able and honeſt Mariners Sailing and continuing an Eaſterly Courſe, have at length arrived (without turning back) to the ſame Place from whence they ſet forth: witneſs Magellanicus, Sir Francis Drake, Tho. Caven- diſh, Oliver vander Noort, W. Schouten, &c.

Secondly, By the length of Degrees in every Parallel; for it is found by Daily obſervation that the Degrees of every Parallel upon the Earth, hold the ſame proportion to the Degrees of the Equinoctial, as the Degrees of the ſame Parallel upon an Artificial Globe or Sphere do to the Degrees of the greateſt Circle of the ſame: This Argument alone is ſufficient; yet take one more from viſible Appearance; and that is this; The ſhadow which the Earth and Water together make in the Eclipse of the Moon is always a part of a Circle; therefore the Earth and Water, which is the Body ſhadowing, muſt alſo be a Circular or Round Body; for if it were three ſquare, four ſquare, or any other form, then would the ſhadow which it makes in the Moon be of the ſame faſhion.

Befides, Of all figures the Sphere or Globe is moſt Per- fect, moſt Capacious, and moſt Intire of it ſelf, without either Joynts or Angles; which form we may alſo per- ceive the Sun, Moon, and Stars to have, and all other things that are bounded by themſelves, as Drops of Wa- ter, and other liquid things.

But

But there is another frequent Argument againſt the Globulous form of the Earth; and that is, That it ſeems impoſſible that the Earth ſhould be Round, and yet alſo Inhabitable in all Places: For though We that Inhabit on the top of the Earth go with our Heads upwards; yet, thoſe that Inhabit underneath us muſt needs go with their Heads downwards, like Flies on a Wall or Ciel- ing; and ſo be in danger of falling into the Air.

For Anſwer hereunto, Firſt, You muſt underſtand that in the Center of the Earth there is an Attractive and Drawing Power, which draws all heavy ſubſtances to it: by virtue of which Attractive Power, things thō looſed from the Earth, will again incline and cling to the Earth, and ſo much the more forcibly, by how much the heavier they are; as a Bullet of Lead let fall out of the Air, inclines towards the Earth far more violently and ſwiftly than a Bullet of the ſame bigneſs of Wood or Cork.

Secondly, You muſt underſtand that in reſpect of the whole Univerſe there is no part either Upper or Under; but all parts of the Earth are alike incompaſt with Hea- ven; yet in reſpect of the Earth, it is Heaven, which we take for the Upper part: and therefore we are ſaid to go with our Heads upwards; becauſe our Head (of all the parts of our Body) is neareſt to Heaven.

Now that this Attractive Power lies in the Center of the Earth is proved by this Argument: If the Attra- ctive Power were not in the Center, a Plumb-line let fall would not make Right Angles with the Superficies of the Earth; but would be Attracted that way the At- tractive virtue lies, and ſo make unequal Angles with the Superficies: But by ſo many Experiments as have yet been made, we find that a Plumb-line continued, though never ſo Deep, yet it alters no Angles with the Superfi- cies of the Earth; and therefore undoubtedly the Attra- ctive Power lies in the very Center, and no where elſe.

B 2

CHAP.

## C H A P. I.

§ I. *What a Globe is.*

A *Globe* (according to the Mathematical Definition) is a perfect and exact round Body, contained under one Surface.

Of this Form (as hath been proved) consists the *Heavens* and the *Earth*: and therefore the Ancients with much Pains, Study and Industry, endeavouring to imitate as well the imaginary as the real appearances of them both, have Invented two *Globes*; the one to represent the *Heavens*, with all the *Constellations*, *fixed Stars*, *Circles* and *Lines* proper thereunto, which *Globe* is called the *Celestial Globe*; and the other with all the *Sea Coast*, *Harbours*, *Rivers*, *Lakes*, *Cities*, *Towns*, *Hills*, *Capes*, *Seas*, *Sands*, &c. as also the *Rumbs*, *Meridians*, *Parallels*, and other *Lines* that serve to facilitate the Demonstration of all manner of Questions to be performed upon the same: and this *Globe* is called the *Terrestrial Globe*.

§ II. *Of the two Poles.*

Every *Globe* hath two *Poles*, the one *North*, and the other *South*. The *North Pole* is the *North* point of the *Globe*: The *South Pole* is the *South* point.

§ III. *Of the Axis.*

From the Center of the *Globe* both ways proceeds a *Line* through both the *Poles*, and continues it self infinitely; which is called the *Axis of the World*; and is represented by the two wyers in the *Poles* of the *Globe*: Upon these two wyers the *Globe* is turned round, even as the *Heavens* is imagined to move upon the *Axis* of the *World*.

§ IV. *Of the Brasen Meridian.*

Every *Globe* is Hung by the *Axis* at both the *Poles* in a *Brasen Meridian*, which is divided into 360 degrees; (or which is all one) into 4 Nineties: the first beginning at the *North Pole*, is continued from the left hand towards the right till the termination of 90 degrees, and is marked with 10, 20, 30, 40, &c. to 90. from whence the degrees are numbred with 80, 70, 60, &c. to 0. which is in the *South Pole*: from whence again the degrees are numbred with 80, 70, 60, &c. to 0. and lastly from 0 the  
degrees

degrees are numbred with 10, 20, 30, to 90. which is again in the *North Pole*.

This *Brasen Meridian* is of great use; for by the help of it you may find the *Latitude* of all Places, the *Right Ascension* and *Declination* of all the *Stars*, &c. and Rectifie the *Globe* to any *Latitude*.

§ V. *Of the Horizon.*

The *Horizon* is a broad Wooden Circle, encompassing the *Globe*; having two Notches in it, the one in the *North*, the other in the *South* point: The Notches are made just fit to contain the *Brasen Meridian* that the *Globe* is Hung in: In the Bottom or under Plain of the *Horizon* there stands up a Prop, or (as it is called) a *Bed*, in which there is also a Notch, into which Notch the *Brasen Meridian* is also let, so low as that both it and the *Globe* may be divided into two equal halves by the upper Plain of the Wooden *Horizon*. These Notches are as gages to keep the *Globe* from inclining more to the one side of the Wooden *Horizon* than the other.

Upon the upper Plain of the *Horizon* is several *Circles* delineated: as first, the *Inner Circle*, which is a *Circle* divided into twelve equal parts, viz. into twelve *Signs*, every *Sign* having its name prefixed to it; as to the *Sign* of  $\gamma$  is the word *Aries*; to  $\tau$  the word *Taurus*, &c. every *Sign* again is divided into 30 equal parts which are called *Degrees*, and every tenth *Degree* is marked with 10, 20, or 30.

Next to the *Circle of Signs* is a *Kalender* or *Almanack*, according to the *Old Stile* used by us here in *England*, each *Month* being noted with its proper name; as *January*, *February*, *March*, &c. and every *Day* distinguished with Arithmetical Figures, as 1, 2, 3, 4, &c. to the end of the *Month*.

The other *Kalender* is a *Kalender* of the *New Stile*; which is in a manner all one with the *Old*; only in this *Kalender* the *Month* begins ten days sooner than they do in the other: and to this *Kalender* (because it was instituted by the Church of *Rome*) there is annexed the *Festival Days* celebrated by the *Romish Church*.

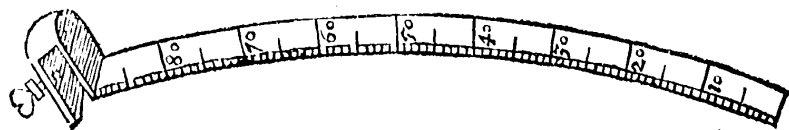
The two other *Circles* are the *Circles* of the *Winds*; the innermost having their *Greek* and *Latine* names, which by them were but twelve; and the outermost having the *English* Names, which for more preciseness are two and thirty.

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The use of the upper plain of the *Horizon* is to distinguish the Day from the Night, the Rising and Setting of the Sun, Moon, or Stars, &c. and for finding the *Azimuth*, and *Amplitude*, &c.

#### § VI. Of the Quadrant of Altitude.

The *Quadrant of Altitude* is a thin Brass Plate, divided into 90 Degrees, and marked upwards with 10, 20, 30, 40, &c. to 90. It is rivited to a Brass Nut, which is fitted to the *Meridian*, and hath a Screw in it, to screw upon any Degree of the *Meridian*. When it is used it is most commonly Screwed to the *Zenith*. Its use is

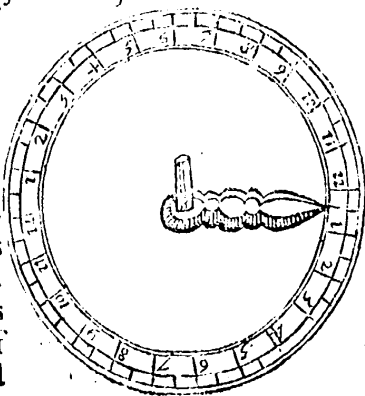


for measuring the *Altitudes*, finding *Amplitudes*, and *Azimuths*, and describing *Almicantaraths*. It would sometimes stand you in good stead if the Plate were longer by the breadth of the *Horizon* than 90 Degrees; for then that length being turned back will serve you instead of an *Index*: when the Nut is screwed to the *Zenith*, to cut either the Degrees or Days of either *Style* or the *Points of the Compass* in any of those *Circles* concentric to the innermost edge of the *Horizon*: which the Eye cannot so well judge at.

#### § VII. Of the Hour Circle, and its Index.

The *Hour Circle* is a small Brass Circle, fitted on the *Meridian*, whose Center is the Pole of the World: It is divided into the 24 Hours of the Day and Night, and each Hour is again divided into Halfs and Quarters, which in a Revolution of the *Globe* are all pointed at with an *Index*, which to that purpose is fitted on the *Axis* of the *Globe*.

The use of the *Hour Circle* is for the shewing the Time of the several Mutations and Configurations of *Celestial Appearances*.



§ VIII.

#### § VIII. Of the Nautical Compass, or Box and Needle.

Just under the *North* point of the *Horizon*, upon the undermost Plain is sometimes fixed a *Nautical Compass*, whose *North* and *South* line must be Parallel to the *North* and *South* line of the *Horizon*. The Use of it is for setting the Angles of the *Globe* correspondent to the Angles of the *World*.

#### § IX. Of the Semi-Circle of Position.

Those that are *Astrologically* addicted, will want a Circle of Position to their Globes.

This is a *Semi-Circle* made of Brass, and divided into 180 degrees, numbred from the Equinoctial on either side with 10, 20, 30, &c. to 90. At the two ends there is an *Axis*, which is fitted into the two Holes of two small Studs, fixed in the *North* and *South* line of the upper Plain of the *Horizon*: upon this *Axis* it is moved up and down, according to the intent of your Operation.

The Use of this *Circle of Position* is, for the finding the twelve *Astrological Houses of Heaven*; and also for finding the *Circle of Position* of any *Star* or *Point in Heaven*.

Thus much may serve for the lineaments circumjacent to the body of the *Globe*. The next discourse shall be

### C H A P. II.

Of the Circles, Lines, &c. described upon the Superficies of the *Globe*; beginning with the *Terrestrial Globe*; and

#### § I. Of the Equator.

THE *Equator* is a great Circle, encompassing the very middle of the *Globe* between the two Poles thereof, and divides it into two equal parts, the one the *North* part, and the other the *South* part. It is (as all Great Circles are) divided into 360 equal parts, which are called *Degrees*. Upon this Circle the *Longitude* is numbred, from *West* to *East*, and from this Circle both ways, *viz.* *North* and *South* the *Latitude* is reckoned. It is called the *Equator*, because when the *Sun* comes to this Line (which is twice in one Year, to wit, on the Tenth of *March*, and

and the Thirteenth of *September*) the *Days* and *Nights* are Equated, and both of one Length.

### § II. Of the Meridians.

There are infinite of *Meridians*, for all Places lying *East* or *West* from one another have several *Meridians*; but the *Meridians* delineated upon the *Terrestrial Globe* are in number 36, so that between two *Meridians* is contained ten *Degrees* of the *Equator*. From the *First* of these *Meridians* (which is divided into twice 90 *Degrees*) accounted from the *Equator* towards either *Pole*, is the beginning of *Longitude*, which upon our *English Globes* is at the *Isle Gratiſa*, one of the *Isles* of the *Azores*, and numbred in the *Equator Eastwards*, with 10, 20, 30, &c. to 360. round about the *Globe*, till it end where it began.

They are called *Meridians*, because they divide the *Day* into two equal parts: for when the *Sun* comes to the *Meridian* of any Place, it is then *Mid-day*, or *Full-Noon*.

### § III. Of the Parallels.

As the *Meridians* are infinite, so are the *Parallels*; and as the *Meridian* lines delineated upon the *Globe* are drawn through no more than every tenth *Degree* of the *Equator*, so are the *Parallels* also delineated but upon every tenth *Degree* of the *Meridian*; lest the *Globe* should be too much filled with Superfluity of *Lines*, which might obscure the small Names of Places. The *Parallel Circles* run *East* and *West* round about the *Globe*, even as the *Equator*, only the *Equator* is a *Great Circle*, and these are every one less than other; diminishing gradually till they end in the *Pole*. The *Parallels* are numbred upon the *Meridian* with 10, 20, 30, &c. to 90. beginning in the *Equator*, and ending in the *Pole*.

They are called *Parallels*; because they are *Parallel* to the *Equator*.

### § IV. Of the Ecliptick, Tropicks, and Polar Circles.

These *Circles* though they are delineated upon the *Terrestrial Globe*, yet they are most proper to the *Celestial*; and therefore when I come to the *Celestial Globe*, I shall define them unto you.

### § V. Of the Rhumbs.

The *Rhumbs* are neither *Circles* nor *streight Lines*, but *Heliſpherical* or *Spiral lines*: They proceed from the Point where we stand, and wind about the *Globe* till they come to the *Pole*; where at last they lose themselves. They represent the 32 *Winds* of the *Compaſs*.

Their Use is to shew the *Bearing* of any two Places one from another: that is to say, upon what *Point* of the *Compaſs* any *Shoar* or *Land* lies from another.

There are many of them described upon the *Globe*, for the better directing the Eye from one *Shoar* to the other, when you seek after the *Bearing* of any two *Lands*. Some of them (where there is room for it) have the figure of the *Nautical Card* drawn about the Center or common interſection, and have (as all other *Cards* have) for the distinction of the *North Point*, a *Flower-de-luce* pictured thereon.

They were first called *Rhumbs* by the *Portugals*; and the name since Used by *Latine* Authors, and continued by all Writers that have Occasion to speak of them.

### § VI. Of the Lands, Seas, Islands, &c. Described upon the Terrestrial Globe.

The *Land* described upon the *Globe* is bounded with an irregular *Line*, which runs turning and winding into *Creeks* and *Angles*, even as the *Shoar* which it represents (doth.) For the better distinction of *Lands*, &c. this line is coloured close by one side thereof with divers *Coulours*, as with *Red*, *Yellow*, *Green*, &c. these *Coulours* distinguish one part of the *Continent* from the other; and also one *Island* from another. That side of the line which incompasses the *Coulours*, is the bounds of the *Land*; the other side of the line which is left bare without *Coulours*, is the limits of the *Water*.

The *Land* is either *Continents*, or *Islands*.

A *Continent* is a great quantity of *Land*, not interlaced or separated by the *Sea*, in which many *Kingdoms* and *Principalities* are contained; as *Europe*, *Asia*, *Africa*, *America*.

An *Island* is a part of the *Earth*, environed round with *Waters*, as *Britain*, *Java*, *S. Laurence Isle*, *Barmudas*, &c.

These again are subdivided into *Peninsula*, *Isthmus*, *Promontorium*.

A *Peninsula* is almost an *Island*; that is, a Track of *Land*, which being almost encompassed round with *Water*, is joyned to the firm *Land*, by some little *Isthmus*; as *Molacca* in the *East-Indies*, &c.

An *Isthmus* is a little narrow Neck of *Land*, which joyneth any *Peninsula* to the *Continent*; as the *Straits* of *Darien* in *Peru*, and *Corinth* in *Greece*.

A *Promontory* is some High *Mountain*, which shooteth it self into the *Sea*, the utmost End or Point of which is called a *Cape*; as that great *Cape of good Hope*, and *Cape Verde* in *Africa*.

The *Water* is either *Ocean*, *Sea*, *Straits*, *Creeks*, *Lakes*, or *Rivers*.

The *Ocean* is that general collection of all *Waters*, which environeth the whole *Earth* on every side.

The *Sea* is a part of the *Ocean*; to which we cannot come but through some *Strait*, as *Mare Mediterraneum*, *Mare Balticum*, and the like.

These take their names either from the adjacent Places, as the *Brittish Ocean*, the *Atlantick Sea*, &c. or from the first Discoverer; as *Mare Magellanicum*; *Davis* and *Forbushers Straits*; &c. Or from some remarkable accident, as *Mare Rubrum*, from the Red colour of the *Sands*; *Mare Egeum*, *Pontus Euxinus*, and the like.

A *Strait* is a part of the *Ocean* restrained within narrow bounds, and opening a way to the *Sea*; as the *Straits* of *Gibraltar*, *Hellepont*, &c.

A *Creek*, is a crooked *Shoar*, thrusting out (as it were) two arms to imbrace the *Sea*, as *Sinus Adriaticus*, *Sinus Persicus*, &c.

A *River* is a small Branch of the *Sea*, flowing into the *Land*; as *Thames*, *Tiber*, *Rhine*, *Nilus*, &c.

Now that these *Lands*, *Islands*, *Towns*, *Seas*, *Rivers*, &c. may at the first search be found upon the *Globe*, all Geographers have placed them thereon according to *Longitude* and *Latitude*.

### § VII. Longitude.

The *Longitude* is an Arch of the *Equator*, comprehended between the *First Meridian* and the *Meridian* of the Place you inquire after. It is numbered on the *Equator* from the *West* to the *Eastwards* with 10, 20, 30, to 360 Degrees, till it end where it began.

### § VIII.

### § VIII. Latitude.

The *Latitude* is an Arch of the *Meridian* comprehended between the *Equator* and the *Place* enquired after. It is numbred on the *Meridian* from the *Equator* both ways, viz. *North* and *South*, till it come to the *Poles*, or 90 Degrees.

Thus much may serve for the description of the *Terrestrial Globe*: I therefore come to treat of the *Cælestial*.

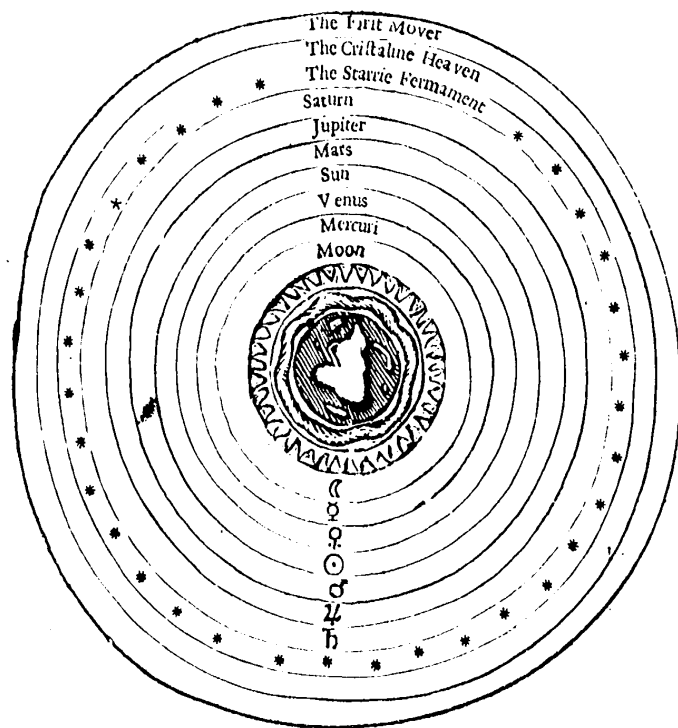
### CHAP. III.

*Of the Cælestial Globe, or the Eighth Sphere, represented by the Cælestial Globe: its Motion, and of the Circles, Lines, Images, Stars, &c. described thereon.*

### § I. Of the eighth Sphere.

THE Eighth Sphere which is the *Starry Heaven*, is represented by the *Cælestial Globe*, because upon the Convexity of it, all the *Stars* and visible appearances are placed according to the order that they are situated in the Concavity of the Eighth Sphere. It is called the Eighth Sphere, because between it and us are contained seven other *Heavens* or *Spheres*; as 1. the *Moon*, 2. *Mercury*, 3. *Venus*, 4. the *Sun*, 5. *Mars*, 6. *Jupiter*, 7. *Saturn*, and eighthly the *Starry Heaven*. The Ancients have made the System of the *World* to consist of two other *Spheres*, called the *Crystalline Heaven*, and the *Primum Mobile*; or first Mover: as in the following Figure is presented.

A Figure wherein may be seen the Composition of the whole frame of the World.



### § II. Of the Motion of the Eighth Sphear.

There hath been attributed to the Eighth Sphear a twofold Motion; the one called its *Diurnal Motion*, which is made from East to West, upon the Poles and Axis of the World, and the other called its *Second Motion*; which is made from West to East upon the Poles and Axis of the *Ecliptick*.

The *Diurnal Motion* is caused by the violent Motion of the *Primum*

*Primum Mobile*; for in 24 Hours it carries along with it, not only the Eighth Heaven or Orb of Fixed Stars, but the Orbs of the Sun, the Moon, and all the rest of the Planets. It is called the *Diurnal Motion*, because it is finished in one Day.

The *Second Motion* is improperly attributed to the Eighth Sphear; it being indeed the Motion of the *Equinoctial*, though Authors sometimes carelessly mention the one instead of the other. Therefore in the next Section, where I treat of the *Equinoctial*, I shall at large explain unto you the nature of this mis-called *Second Motion*.

### § III. Of the Equinoctial.

The *Equinoctial* on the *Celestial Globe*, is the same line formerly called the *Equator* upon the *Terrestrial*; only with this difference, that the *Equator* remains fixt upon the *Terrestrial Globe*, but the *Equinoctial* upon the *Celestial Globe* is moveable; (or at least must be imagined to move) contrary to the *Diurnal Motion* from West to East, upon the Poles of the *Ecliptick*: I say imagined to move, because in the Heavens it, with its whole Orb, viz. the Eighth Sphere, doth really move, though on a material Globe it would be inconvenient to make a moveable *Equinoctial*, and therefore it hath one fixed: which for this and the next Age will sufficiently serve, without much deviation from the Truth it self.

Now that the difference between the *Equator* upon the *Terrestrial Globe*, and the *Equinoctial* upon the *Celestial*, may be proved; and the Motion of the *Equinoctial* be the better understood; I shall only bring this Example;

All places that were formerly under the *Equator*, do and will keep the same *Longitude*, and remain still under the *Equator*: as may be proved by comparing the Ancient and Modern Geographers together: but those Stars that were formerly under the *Equinoctial*, do not keep the same *Longitude*, nor remain under the *Equinoctial*: because the *Equinoctial* (as aforesaid) hath a Motion from West to East, upon the Poles of the *Ecliptick*. But the Stars being fixed in their own Sphear, like knots in Wood, and therefore move not, are by the Precession of the *Equinox* left behind the *Equinoctial Celure*, and so are caused to alter their *Longitude*; as by comparing the Observations of ancient and Modern Astronomers together, it will appear; for about 346 Years

Years before Christ, the first *Star* in the *Rams horn* was by the *Egyptian and Grecian Astronomers* Observed to be in the *Equinoctial Colure*: and 59 Years ago, when *Tycho* Observed, it was found to be in 27 Degrees 37 Minutes of  $\gamma$ . So that in about 2000 Years it is moved forwards 28 Degrees, and will according to *Tycho's* opinion, finish its Revolution in 25412 Years: According to which Motion, I have Calculated this following Table, for finding the Degrees and Minutes of the *Equinoctial* Motion, answerable to any number of Years within the said Revolution.

ye.	deg.	m.	years.	deg.	m.
1	0	0	100	1	25
2	0	1	200	2	50
3	0	2	300	4	15
4	0	3	400	5	40
5	0	4	500	7	5
6	0	5	1000	14	10
7	0	5	2000	28	20
8	0	6	3000	42	30
9	0	7	4000	56	40
10	0	8	5000	70	50
20	0	17	10000	141	40
40	0	34	20000	283	20
60	0	51	25000	354	10
80	1	8	25412	360	

This Table may be of Use for finding the *Equinoctial* position of any *Star*, for any Year either past, present or to come. Its use is very easie: For if you desire to know the Motion of the *Equinox* for any number of Years, you need but seek your number in the Column of Years, and against it you have the Degrees and Minutes of the *Equinoctial* Motion.

But though the *Stars* have this Motion one way, viz. in *Longitude*, yet do they not at all alter their *Latitudes*; Because the Motion of the *Equinoctial* is made upon the Poles of the *Ecliptick*.

§ IV.

## § IV. Of the Ecliptick.

The *Ecliptick* is a Great Circle, lying oblique or aslope from the *Equinoctial*, making an Angle of  $23\frac{1}{2}$  Degrees with it: It cuts the *Equinoctial* into two equal parts, and is cut by the *Equinoctial* in two opposite points, viz. in  $\gamma$ , and  $\pi$ . It divides the *Globe* into two equal parts, called *Hemisphere*; the one the *North*, and the other the *Southern Hemisphere*. It is divided into 12 equal Parts, which are called the twelve *Signs*; every part being noted with the Character of the *Sign* belonging unto it, as unto *Aries*,  $\gamma$ , to *Taurus*,  $\tau$ , to *Gemini*,  $\mu$ , and so of the rest. From every one of these 12 divisions proceed both ways, viz. *North*, and *South*, *Circles of Longitude*, into the *Poles* of the *Ecliptick*. Each of these twelve *Signs* is divided into 30 equal parts, which are called *Degrees*; and are numbered upon every tenth *Degree* with 10, 20, to 30, and upon my new *Celestial Globe* for more preciseness, every *Degree* is again divided into halves.

“It is called the *Ecliptick* as being derived from the Greek word *Eklepsin*, which signifies to want Light: Because in “and about it happen all the defects and *Eclipses* both of the “*Sun* and the *Moon*.

“It is also called the way of the *Sun*, because the *Sun* goes all “ways under it, passing through it in all his *Annual* Course.

## § V. Of the Poles of the Ecliptick.

There are two *Poles* of the *Ecliptick*, the one the *North Pole*, the other the *South Pole*; and are called *North* or *South* according to their position next the *North* or *South Pole* of the *World*. Each is distant from its correspondent *Pole* of the *World* 23 Degrees 30 Minutes.

As on the *Terrestrial Globe* all the *Meridians* described thereon meet in the *Pole* of the *World*, so on the *Celestial* all the *Circles of Longitude* drawn through the *Twelve Signs* meet in the *Poles* of the *Ecliptick*.

§ VI.

## § VI. Of the Axis of the Ecliptick.

Through the *Poles* of the *Ecliptick* is imagined to pass a straight line through the Center of the Plain of the *Ecliptick*: which is called the *Axis of the Ecliptick*, upon which the *Second Motion* of the *Ecliptick* is performed, even as the *Diurnal Motion* is performed upon the *Axis of the World*.

## § VII. Of the Colures, and Cardinal Points.

There are two Great Circles cutting one another at right Angles in the *Poles of the World*, which are called the *Colures*. Each *Colure* receives an additional name from the point in the *Ecliptick* that it cuts; as the one passes from *Pole to Pole* through the beginning of  $\gamma$  and  $\alpha$ , which being two *Equinoctial Signs*, names therefore that *Colure* the *Equinoctial Colure*: The other passes through the beginning of  $\vartheta$  and  $\varpi$ , which are *Solstitial Signs*, and therefore names that the *Solstitial Colure*.

These *Colures* by intersecting one another, divide themselves into four Semi-circles; and these Semi-circles divide the *Ecliptick* into four equal parts, viz.  $\gamma$ ,  $\vartheta$ ,  $\alpha$ , and  $\varpi$ .

The point of the *Ecliptick* that these intersections pass through, are called the four *Cardinal points*; and are of great use in *Astronomy*; for according to the *Sun's* approach to any of them, the Season of the Year is altered into *Spring*, *Summer*, *Autumn*, *Winter*: as shall be shewed hereafter.

## § VIII. Of the Tropicks.

There are two smaller Circles Parallel to the *Equinoctial*, which are called the *Tropicks*, the one called the *Tropick of Cancer*, the other the *Tropick of Capricorn*: they are distant from the *Equinoctial* 23 Degrees 30 Minutes; and therefore are the bounds of the *Ecliptick*. They receive their names from the *Cælestial Sign* that they are joyned unto; as the one the *Tropick of Cancer*, because it touches the *Sign of Cancer*, the other the *Tropick of Capricorn*, because it touches the *Sign of Capricorn*.

§ IX.

## § IX. Of the Circles Arctick and Antarctick.

About the *Poles of the World* are described two small Parallel Circles; the one called the *Arctick*, the other the *Antarctick*. That in the *North* is called the *Arctick Circle*, that in the *South* the *Antarctick Circle*.

They have the same distance from the *Poles of the World* that the *Tropicks* have from the *Equinoctial Circle* (viz. 23 Degrees 30 Minutes) and that the *Ecliptick* hath from the *Poles of the World*; and therefore run through the *Poles of the Ecliptick*.

## § X. Of the Images called Constellations, drawn upon the Celestial Globe.

Here I think fit to be beholden to Dr. Hood, for the pains he hath taken in his Comment on the *Images and Constellations*. He saith, The *Stars* are brought into *Constellations* for instructions sake: things cannot be taught without Names; to give a Name to every *Star* had been troublesome to the Master, and for the Scholar; for the Master to devise, and for the Scholar to remember: and therefore the *Astronomers* have reduced many *Stars* into one *Constellation*, that thereby they tell the better where to seek them; and being sought, how to express them.

All the *Constellations* formerly notified by the Antients were in number 48, twelve whereof we call the *twelve Signs* of the *Zodiack*, viz. 1 Aries,  $\gamma$ , 2 Taurus,  $\vartheta$ , 3 Gemini,  $\pi$ , 4 Cancer,  $\vartheta$ , 5 Leo,  $\alpha$ , 6 Virgo,  $\varpi$ , 7 Libra,  $\alpha$ , 8 Scorpio,  $\mu$ , 9 Sagittarius,  $\tau$ , 10 Capricorn,  $\varpi$ , 11 Aquarius,  $\alpha$ , 12 Pisces,  $\kappa$ . One and twenty more are placed in the *North Hemisphere*, and are called 1 *Ursa minor*, 2 *Ursa major*, 3 *Draco*, 4 *Cepheus*, 5 *Bootes*, 6 *Corona Septentri*, 7 *Hercules*, 8 *Lyra*, 9 *Cygnus*, 10 *Cassiopea*, 11 *Perseus*, 12 *Auriga*, 13 *Serpentarius*, 14 *Serpens Ophiuchi*, 15 *Sagitta*, 16 *Aquila*, 17 *Delphinus*, 18 *Equiculus*, 19 *Pegasus*, 20 *Andromeda*, 21 *Triangulum*. The other 15 are situate in the *South Hemisphere*, and called 1 *Cetus*, 2 *Orion*, 3 *Eridanus*, 4 *Lepus*, 5 *Canis major*, 6 *Canicula*, 7 *Argo Navis*, 8 *Hydra*, 9 *Crater*, 10 *Corvus*, 11 *Centaurus*, 12 *Lupus*, 13 *Ara*, 14 *Corona Austrina*, 15 *Pisces Austrina*. Besides, there are two other *Constellations* in the *North Hemisphere*, viz. *Antinous*,  
D and



and *Coma Berenices*: which because they were not specified by the Ancients, are here inserted apart.

Now the *Astronomers* did bring them into these Figures, and not into other, being moved thereto by these three Reasons: First, these Figures express some properties of the *Stars* that are in them; as those of the *Ram* to be Hot and Dry; *Andromeda* chained betokeneth Imprisonment: the Head of *Medusa* cut off, signifieth the loss of that part: *Orion* with his terrible and threatening gesture, importeth Tempest and terrible effects: The *Serpent*, the *Scorpion*, and the *Dragon* signify poyson: The *Bull*, innuatieth a Melancholly passion: The *Bear* inferreth Cruelty, &c. Secondly, the *Stars* (if not precisely, yet after a sort) do represent such a Figure, and therefore that Figure was assigned them: as for Example, the *Crown*, both North and South; the *Scorpion* and the *Triangle*, represent the Figures which they have. The third Cause was, the continuance of the Memory of some notable Men, who either in regard of their singular pains taken in *Astronomy*, or in regard of some other notable deed, had well deserved of Mankind.

The first Author of every particular *Constellation* is uncertain; yet are they of great Antiquity; we receive them from *Ptolomy*, and he followed the *Pythagoricks*; so that their Antiquity is great. Moreover, we may perceive them to be Ancient by the *Scriptures*, and by the *Poets*. In the 38 Chapter of *Job* there is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which some interpret the 12 Signs: *Job* lived in the Time of *Abraham*, as *Sydenham* maketh mention in his Book *de Commensurandis locorum distantis*.

Now besides all this, Touching the reason of the invention of these *Constellations* the *Poets* had this purpose, viz. to make Men fall in love with *Astronomy*. And to that intent have to every *Constellation* invented strange conceited *Stories*; (as you may read at the latter end of this Book) therein imitating *Demosthenes*, who when he could not get the People of *Athens* to hear him in a matter of great moment, and profitable for the Commonwealth, he began to tell them a Tale of a Fellow that sold an *Ass*; by which Tale, he brought on the *Athenians*, that they were both willing to hear his whole Oration, and to put in Practice what he exhorted them to. The like intent had the *Poets* inventing of those *Stories*: They saw that *Astronomy* being

ing for commodity singular in the life of Man, was almost of all Men utterly neglected: Hereupon they began to set forth that Art under *Fictions*; that thereby, such as could not be persuaded by commodity, might by the pleasure be induced to take a view of these Matters: and thereby at length fall in love with them. For commonly you shall note this, that he that is ready to Read the *Stories*, cannot content himself therewith, but desireth also to know the *Constellation*, or at leastwise some principal *Star* therein.

There are in *Heaven* yet twelve *Constellations* more, posited about the *South Pole*, which were added by *Frederico Houtmanno*, inhabiting on the Island *Sumatra*; who being accommodated with the Instruments of immortal *Tycho*, hath observed the *Longitude* and *Latitude* of those *Stars*, reduced them into *Constellations*, and named them as follows, 1 The *Crane*, 2 The *Phoenix*, 3 The *Indian*, 4 The *Peacock*, 5 The *Bird of Paradise*, 6 The *Fly*, 7 The *Camelion*, 8 The *South Triangle*, 9 The *Flying Fish*, 10 *Dorado*, 11 The *Indian Fowl*, 12 The *Southern Serpent*.

#### § XI. Of the number of the Stars.

Although in *Heaven* there be a very great number of visible *Stars*, which for their multitude seem innumerable, yet no wise Man will from thence infer that they are impossible to be counted: for there is no *Star* in *Heaven* that may be seen, but its *Longitude* and *Latitude* may with meet Instruments for that purpose be exactly found; and being once found, it may have a Name allotted it, which with its *Longitude* and *Latitude* may be Catalogized either for the Memory of the Observer, or the knowledge of Posterity. Now therefore if any one *Star* may be Observed, they may all be Observed; and then may they all have Names given them; which though to the ignorant it seem incredible, yet to the Sons of God (as *Josephus* calls *Astronomers*) who herein participate of their Fathers knowledge, it is easie to number the *Stars*, and call them all by their Names, *Psalm* 97. 4.

But though all the *Stars* in *Heaven* may be numbred and named, yet hath not *Tycho* or the Ancient *Astronomers* thought fit to take notice of more than 1241 of the chiefest that are visible in our *Horizon*, they being sufficient for any purpose that we shall have occasion to apply them unto. Yet of late

the industry of *Fred. Houtman* aforesaid, hath added to the Catalogue 136 Stars, with their *Longitude*, *Latitude*, and *Magnitude*, and given Names unto them: which upon my New Globes I have also ascertained, as may be seen about the *South Pole* thereof. So that with these 1241 Observed by *Tycho* and the Ancients, and these 136, the whole number of the Catalogue is 1377.

Some other Stars of late have been also observed by *Baierus*, among the several *Constellations* aforesaid; but not of any considerable *Magnitude*: and therefore I think fit to pass them by, and come to their Situation in *Heaven*, according to *Longitude* and *Latitude*.

### § XII. Of the Situation of the Stars.

Longitude of the Stars.

The Stars are Situate in *Heaven* according to their *Longitude* and *Latitude*. As the *Longitude* of any Place on the *Terrestrial Globe* is an Arch of the *Equator* comprehended between the first *Meridian* and the Place; so the *Longitude* of any Star on the *Celestial Globe* is an Arch of the *Ecliptick* contained between the first point of *Aries* and the Star inquired after. But yet because the *Ecliptick* is divided into 12 Signs, the *Longitude* of a Star is therefore (in the most customary Account) an Arch of the *Ecliptick* comprehended between the Semi-circle of *Longitude*, passing through the beginning of the Sign the Star is in, and the Semi-circle of *Longitude* passing through the Center of the Star.

Latitude of the Stars.

The *Latitude* of a Star is either *North* or *South*: *North* if on the *North* side of the *Ecliptick*; *South* if on the *South* side of the *Ecliptick*. As the *Latitude* of any Place on the *Terrestrial Globe* is an Arch of the *Meridian* contained between the *Equator* and the *Parallel* of the Place, so is the *Latitude* of any Star on the *Celestial Globe* an Arch of a Semi-circle of *Longitude* comprehended between the *Ecliptick* and the Star inquired after.

### § XIII. Of the Magnitudes of the Stars.

For the better distinction of the several sizes of Stars, they are divided into six several *Magnitudes*. The biggest and brightest Stars are called Stars of the first *Magnitude*: Those

one

one size inferiour in Light and Bigness are called Stars of the Second *Magnitude*: Those again one size inferiour to the Stars of the Second *Magnitude*, are called Stars of the Third *Magnitude*, and so the Stars gradually decrease unto the Sixth *Magnitude*, which is the smallest, some few Obscure Stars only excepted, which for their minority and dimness are called *Nebula*. These several *Magnitudes* of the Stars are expressed on the *Globe* in several shapes: as may be seen in a small Table placed on the *Globe* for that purpose.

Now for your further satisfaction and delight, I have inserted a Collection of *Dr. Hoods*, wherein is expressed the Measure of every *Magnitude*, and the Proportion it hath, first, to the *Diameter*, and secondly to the *Body* of the *Earth*.

The Measures of the several Stars.

The greatness of any thing (saith he) cannot be better expressed than by comparing it to some Common Measure, whose quantity is known: the Common Measure whereby *Astronomers* express the greatness of the Stars, is the *Earth*.

Sometimes they compare them with the *Diameter* of the *Earth*, sometimes with the *Globe* thereof: The *Diameter*, according to their account which allow but 60 Miles to a Degree, containeth 6822  $\frac{7}{8}$  Miles; and the whole Solidity of the *Globe* contains 165,042;481,283 Miles and  $\frac{7}{8}$ . According to *Ptolomy*, who allottereth to every Degree 62  $\frac{1}{2}$  Miles: The *Diameter* containeth 7159 Miles  $\frac{1}{2}$ , and the whole Solidity of the *Globe* hath 192,197;184,917  $\frac{4}{3}$  Miles.

### The proportion of the Diameters of the fixed Stars, compared with the Diameter of the Earth.

The *Diameter* of a Fixed Star of the First *Magnitude* compared with the *Diameter* of the *Earth* hath such Proportion to it as 19 hath to 4: therefore it containeth the *Diameter* of the *Earth* 4 times and  $\frac{1}{4}$ .

The *Diameter* of a Star of the Second *Magnitude* is unto the *Diameter* of the *Earth* as 269 is to 60: therefore it containeth it 4  $\frac{2}{3}$  times.

The *Diameter* of a Fixed Star of the Third *Magnitude* is unto the *Diameter* of the *Earth* as 25 unto 6: therefore it containeth it 4  $\frac{1}{6}$  times.

The *Diameter* of a Fixed Star of the Fourth *Magnitude* is unto the

the

the Diameter of the *Earth* as 19 unto 5 : therefore it containeth it  $3\frac{4}{5}$  times.

The Diameter of a *Fixed Star* of the *Fifth Magnitude* is unto the Diameter of the *Earth*, as 119 unto 36, therefore it containeth it  $3\frac{11}{16}$  times.

The Diam. of a *Fixed Star* of the *Sixth Mag.* is unto the Diam. of the *Earth*, as 21 unto 8 ; therefore it containeth it  $\frac{1}{8}$  times.

As for the Proportions of the Cloudy and Obscure *Stars*, they are not expressed ; because they are but few, and of no great account in respect of their smallness.

*The Proportions of the Fixed Stars compared with the Globe of the Earth, are as follow.*

A *Star* of the *First Magnitude* is to the *Globe* of the *Earth*, as 6859 to 64, therefore it containeth the *Globe* of the *Earth*  $107\frac{1}{8}$  times.

A *Star* of the *Second Magnitude* is to the *Globe* of the *Earth*, as 19465109 is to 216000, therefore it containeth it  $90\frac{1}{3}$  times.

A *Star* of the *Third Magnitude* is to the *Globe* of the *Earth*, as 15625 is unto 216, therefore it containeth it  $72\frac{1}{3}$  times.

A *Star* of the *Fourth Magnitude* is to the *Globe* of the *Earth*, as 6850 is unto 125 : therefore it containeth the *Globe* of the *Earth*  $54\frac{1}{2}$  times.

A *Star* of the *Fifth Magnitude* is to the *Globe* of the *Earth*, as 1685159 is unto 46656, therefore it containeth the *Globe* of the *Earth*  $36\frac{1}{3}$  times.

A *Star* of the *Sixth Magnitude* is to the *Globe* of the *Earth*, as 9261 is unto 512, therefore it containeth the *Globe* of the *Earth*  $18\frac{1}{2}$  times.

I confess all this may seem matter of incredulity to those whose understanding is swayed by their visual Sense, but if they be capable to consider the vast distance of those Huge Bodies (the *Stars*) from the face of the *Earth*, and also the diminutive quality of Distance, their reason will be rectified; and their incredulity turn'd into an acknowledgment of the unspeakable Wisdom of Almighty God; and they will say with the *Psalmist*, Great is our Lord, Great is his Power, his Wisdom is infinite, *Psalm*. 147.5.

The distance of the *Stars* therefore from the *Earth*, is according to Mr. *John Dee's* Computation, 20081 $\frac{1}{2}$  Semidiameters

ters of the *Earth*. The Semidiameter of the *Earth* containeth of our common *Miles* 3436 $\frac{1}{4}$ , Such *Miles* as the whole *Earth* and *Sea* round about is 21600: allowing for every *Degree* of the greatest *Circle* 60 *Miles*: so that the distance of the *Stars* from the *Earth* is in *Miles* 69006540. Now as Mr. *Dee* saith (almost in the same words) if you weigh well with your self this little parcel of Fruit *Astronomical*; as concerning the Bigness and Distance of the *Stars*, &c. and the huge massiness of the *Starry Heaven*, you will find your Consciences moved with the *Kingly Prophet* to sing the Confession of God's Glory; and say, *The Heavens declare the Glory of God, and the Firmament sheweth forth the Works of his Hands.*

#### § XIV. Of the Nature of the Stars.

To many of the Principal *Stars* there is in *Planetical* Characters prefixed their *Planetical Natures*. The *Astrologers* make great use of them for knowing the *Nature* of the *Stars*: for those *Stars* that have the Character of *h* adjoyned, are said to be of the *Nature* of *h*: those that have *u* adjoyned, are of the *Nature* of *u*: and so of the rest. If a *Star* have the Characters of two *Planets* adjoyned, that *Star* participates of both their *Natures*, but most of that *Planets* whose character is first placed.

The use *Astronomers* make of those Characters, is for knowing the colour of any *Star*; as if a *Star* have *h* adjoyned, it is of the colour of *h*; if *u*, it is the colour of *u*, &c.

The *Fixed Stars* are known from the *Planets* by their continual *Twinkling*, for the *Planets* never *Twinkle*, but the *Fixed Stars* do.

#### § XV. Of *Via Lactea*, or the *Milky way*.

This Subject, because it is already so fully handled by Dr. *Hood*, that more than he hath Written cannot well be said, either of his own Opinion or other Mens, I think fit therefore to give you his own Words, which are as follow,

VIA LACTEA, or *Circulus Lacteus* by the *Latines* so called; and by the *Greeks*, *Galaxia*, and by the *English* the *Milky way*. It is a broad white Circle that is seen in the *Heaven*: In the North *Hemisphere*, it beginneth at *Cancer*, on each side the Head thereof, and passeth by *Auriga*, by *Perseus*, and *Cassiopeia*, the *Swan*, and the Head of *Capricorn*, the Tail of *Scorpio*, and

and the Feet of *Centaur*, *Argo* the *Ship*, and so unto the Head of *Cancer*. Some in a sporting manner do call it *Watling-street*, but why they call it so, I cannot tell; except it be in regard of the narrowness that it seemeth to have; or else in respect of that great High-way that lyeth between *Dover* and *S. Albans*, which is called by our Men *Watling-street*.

Concerning this Circle there are sundry Opinions; for there is great difference among some Writers, both touching the Place, Matter, and Efficient Cause thereof. *Aristotle* dissenteth from all other, both *Philosophers* and *Poets*, in the Place, Matter, and Cause of this Circle; saying, That it is a *Meteor* ingendered in the *Air*, made of the *Vapors* of the *Earth*, drawn up thither by the Heat of the *Sun*, and there set on Fire. But his Opinion is of all men confuted.

First, Touching the Place, it cannot be in the *Air*; for whatsoever is in the *Air*, is not seen of all Men, at all Times, to be under one and the same Part of *Heaven*. If we see it in the *South*, they that are in the *West* shall see it under the *East* side of the *Heaven*, and they that are in the *East*, shall see it in the *West* Part of the *Heaven*; But this Circle is of all Men seen always under the same Part of *Heaven*, and to be joyned with the same *Stars*; therefore it cannot be in the *Air*.

Again, For the Matter, it cannot be made of that which *Aristotle* nameth (*i.e.*) the *Vapours* of the *Earth*, because of the long continuance of the Thing, and that without any Alteration; for it is impossible that any *Meteor* made of *Vapours* drawn up from the *Water*, or *Exhalations* from the *Earth*, should last so Long; as may be seen in *Blazing Stars*; which though they have continued Long, as namely 16 Months, some more, some less; yet at the length they have vanished away: whereas this Circle hath continued from the Beginning unto this Day. Besides, put case it were made of these *Exhalations*; whence will they infer the uniformity thereof? The *Comets* do alter diversely, both in the Fashion of their Blazing, and also in their several Quantities; whereas in this Circle, there is nothing but the same Part, always of one Form and of one Bigness. In the Efficient Cause thereof he must needs err: for if it be neither in the *Air*, nor made of the *Exhalations* of the *Earth*, it cannot be caused by the *Sun*; for the one is the Place, and the other the Matter, wherein, and whereupon the *Sun* sheweth All

All other (besides *Aristotle*) agree in the Place, but differ in the Efficient cause thereof: and they are either *Philosophers*, or *Poets*. Both these affirm that it is in the *Firmament* (*i.e.*) in the *Eighth Sphere*; but they disagree in the Cause thereof.

The *Philosophers* (and chiefly *Democritus*) affirm the Cause of the thing, to be the exceeding great number of *Stars* in that part of *Heaven*, whose beams meeting together so confusedly, and not coming distinctly to the Eye, causeth us to imagine such a Whiteness as is seen. But the best Opinion is this, that this *Milky way* is a part of the *Firmament*, neither so Thin as the other parts thereof are, nor yet so Thick as the *Stars* themselves. If it were as thin as the other Parts of the *Heaven* besides the *Stars*, then could it not retain the Light, but the Light would pass through it and not be seen: If it were as Thick as the *Stars*, then would the Light be so doubled in it, that it would Glisten and Shine, as the *Stars* themselves do: but being neither so Thin as the One, nor so Thick as the Other, it becometh of that Whiteness we see. Thus far Dr. Hood. But

Our modern *Philosophers* conceive this *Lactean* Whiteness ariseth from a great number of little *Stars*, constipated in that part of *Heaven*; flying so swiftly from the sight of our Eyes, that we can perceive nothing but a confused Light: this the *Telescope* (more lately found out) doth evidently demonstrate to us: by the Benefit of which, little *Stars* (otherwise inconspicuous to our Eyes) are there clearly discerned.

About the Southern Pole are seen two *White Spots*, like little *Clouds*, coloured like the *via Lactea*. One of which is treble the Latitude of the Other; some *Mariners* call them *Nubeculae Magellani*.

This *Milky way* is described on the *Globe* between two Tracks of small Pricks running through the *Images* mentioned in the beginning of this Section.

Thus have you the definition of the *Globes*; with the Description of all the *Lines*, *Circles*, &c. described thereon. I shall now explain unto you the meaning of several Words of Art, which in the Use of them you will meet with; and then come to the Use it self.

And first, what is meant by the word *Horizon*.

## § XVI.

When I spake of the *Horizon* before, I only mentioned the Wooden *Horizon* or Frame about the *Globe*; which because it represents the *Mathematical Horizon*, is therefore called the *Horizon*: but the word *Horizon* is to be considered more particularly two manner of ways: as

First, the *Natural Horizon*,

Secondly, the *Mathematical Horizon*.

The *Natural Horizon* is that apparent Circle which divides the Visible part of *Heaven* from the Invisible; it extends it self in a straight Line from the Superficies of the *Earth*, every way round about the Place you stand upon, even into the very circumference of the *Heavens*. It is only discerned at *Sea*, or on plain Ground, that is free from all hindrance of the Sight, as *Hills*, *Trees*, *Houses*, &c.

The *Mathematical Horizon* (which indeed is meant in this Treatise, so oft as I shall have occasion to name the word *Horizon*) is a great Circle which divides that part of *Heaven* which is above us, from that which is under us, precisely into two equal parts: whose *Poles* are the *Zenith* and *Nadir*. In this Circle the *Azimuths* or *Vertical Circles* are numbred: and by this Circle our *Days* and *Nights* are measured out unto us: for while the *Sun* is above the *Horizon* it is *Day*; and when it is under the *Horizon* it is *Night*.

This Circle is represented unto us by the upper Plain of the Wooden *Horizon*: Therefore so oft as you are directed to Bring any *Degree* or *Star*, &c. to the *Horizon*, it must be understood that you must turn the *Globe* till the *Degree* or *Star* come just to the upper Inner edge of the Wooden *Horizon*.

The *Zenith* and *Nadir*, are two points opposite to one another: The *Zenith* is that point in *Heaven* directly over our Heads: and the *Nadir* is that point in *Heaven* directly under our Feet.

The *Azimuths* or *Vertical Circles* are great Circles passing through the *Zenith* and *Nadir*, whose *Poles* are the *Zenith* and *Nadir*. And as the *Meridians* cut the *Equator* and all *Parallels* to the *Equator* at right Angles, so the *Azimuths* cut the *Horizon* and all *Almicantbars* at right Angles also. The *Azimuths* (as the *Meridians*) are infinite; and are numbred by *Degrees* from the *East* and *West* points towards the *North* and *South* in the *Horizon*. The

*Zenith*.

*Nadir*.

*Azimuth, or Vertical Circles.*

The *Almicantbars* are Circles parallel to the *Horizon*, whose *Poles* are the *Zenith* and *Nadir*. They are so called *Circles of Altitude*, because when the *Sun*, *Moon*, or any *Star* is in any number of *Degrees* above the *Horizon*, it is said to have so many *Degrees of Altitude*; which *Degrees of Altitude* are numbred on the *Vertical Circle* from the *Horizon* upwards, towards the *Zenith*. The *Almicantbars* are also infinite, as *Parallels*, *Meridians* and *Azimuths* are.

The *Amplitude* is the number of *Degrees* contained between the true *East* or *West* point towards the *North* or *South* points of the *Horizon*, and the *Rising* or *Setting* of the *Sun*, *Moon*, or *Stars*, &c.

The *Declination* is the number of *Degrees* that the *Sun*, *Moon*, or any *Star* is distant from the *Equinoctial* towards either *Pole*: and hath a double denomination, viz. *North Declination*, and *South Declination*: for if the *Sun*, *Moon*, or *Star* swerve towards the *North Pole*, they are said to have *North Declination*; if towards the *South Pole*, *South Declination*.

The *Right Ascension* is the number of *Degrees* of the *Equinoctial* (accounted from the first point of *Aries*) which comes to the *Meridian* with the *Sun*, *Moon*, or *Star*, or any other point in *Heaven* proposed.

The *Oblique Ascension* is the number of *Degrees* of the *Equinoctial* which comes to the *East* side the *Horizon* with the *Sun*, *Moon*, or any *Star*.

The *Oblique Descension* is the *Degrees* of the *Equinoctial* which comes to the *West* side the *Horizon* with the *Sun*, *Moon*, or any *Star*.

The *Ascensional Difference* is the number of *Degrees* after Subtraction of the *Oblique Ascension* from the *Right Ascension*.

So many *Degrees* as you Sail towards the *Pole*, you are said to *Raise the Pole*; and so many *Degrees* as you Sail from the *Pole*, you are said to *Depress the Pole*.

*Course* is the point of the *Compass* you Sail upon; as if you Sail *Eastward*, it is an *Easterly Course*, if *West*, a *Westerly Course*, &c.

*Distance* is the number of *Leagues* you have Sailed from any Place, upon any *Course*.

A *Zone* is a space of the *Earth* contained between two *Parallels*. The Ancient Geographers made five *Zones* in the *Earth*; two *Frozen*, two *Temperate*, and one *Burnt Zone*.

Frozen Zone.

The two *Frozen Zones* are those parts of the *Globe* comprehended between the *North Pole* and the *Arctic Circle*, and the *South Pole* and the *Antarctic Circle*; by the Ancients called *Inhabitable*, Because the *Sun* being always far remote from them shoots its Beams obliquely upon them, which oblique Beams are so very weak, that all their *Summer* is but a continued *Winter*, and the *Winter* (as they thought) impossible to be at all indured.

Temperate Zone.

The *Temperate Zones* are the space of *Earth* contained between the *Arctic Circle* and the *Tropick of Cancer*, and the *Antarctic Circle* and the *Tropick of Capricorn*; by the Ancients called *Temperate* and *Habitable*; Because they are composed of a sweet mediocrity, between outrageous Heat, and extremity of Cold.

Burnt Zone.

The *Burnt Zone* is the space of *Earth* contained between the *Tropick of Cancer*, and the *Tropick of Capricorn*, called by the Ancients *Unhabitable*, because in regard the *Sun* never moves out of this *Zone*, but darts its Beams perpendicularly upon it, they imagined the Air was so unsufferable Hot, that it was impossible for any to Inhabit in this *Zone*. So that (as you see) they held the two *Temperate Zones* only habitable; and the two *Frozen Zones* and one *Burnt Zone* altogether impossible to be Inhabited. But their Successors, either animated by industry, or compelled by necessity, have apparently refuted their Assertion; for at this time many thousands can witness that their Bloods are not so greasy as to Melt in the scorching Heat of the One, or so Watry as to Congeal in the *Icy Frosts* of the Other.

Climates.

The Ancients have yet otherwise divided the *Earth* into four and twenty *Northern Climates*, and four and twenty *Southern Climates*; so that in all there is eight and forty *Climates*. The *Climates* are altered according to the half Hourly increasing of the Longest Days; for in the *Latitude* where the Longest Days are increased half an Hour Longer than they are at the *Equator* (viz. Longer than 12 Hours) the first *Climate* begins; and in the *Latitude* where they are increased an whole Hour Longer than in the *Equator*, the second *Climate* begins; where the Days are increased three half Hours Longer than in the *Equator*, the third *Climate* begins; and so onwards, the *Climates* alter according as the Longest Day increases half an Hour, till you come to find the Longest Day 24 hours Long.

Now the Ancients (in those Times) knowing no more than nine *Habitable Climates*, gave names only to nine. The first they

they called *Dia Meros*, after the name of a famous In-land Island, which is situate about the middle of that *Climate*, and is now called *Gueguere*. The second *Climate* they called *Dia Syenes*, after the name of an eminent City in *Egypt*, lying about the midst of that *Climate*. The third *Dia Alexanderas*, after the name of the Metropolitan City of *Egypt*. The fourth *Dia Rhodas*. The fifth *Dia Romes*. The sixth *Dia Ponton*. The seventh *Dia Boristheneos*. The eighth *Dia Ripheos*. The Ninth *Dia Daniam*.

These Names belong only to the *Climates* on the *North* side of the *Equator*. But those on the *South* side (in regard of the small Discoveries those Ages had on that side the *Equator*) were distinguished only by the addition of the word *Anti*, to the same *Southerly Climate*: as the first *Southern Climate* (which is that *Climate* that lies as many Degrees to the *Southward* as the first doth to the *Northward*) they called *Anti Meros*. The second *Anti Syenes*. The third *Anti Alexanderas*, and so on to the ninth.

In every *Climate* is included two *Parallels*, which are of the same Nature with the *Climates*; save only that as the *Climates* alter by the half hourly increasing of the longest day, the parallels alter by the Quarter Hourly increasing of the longest Day.

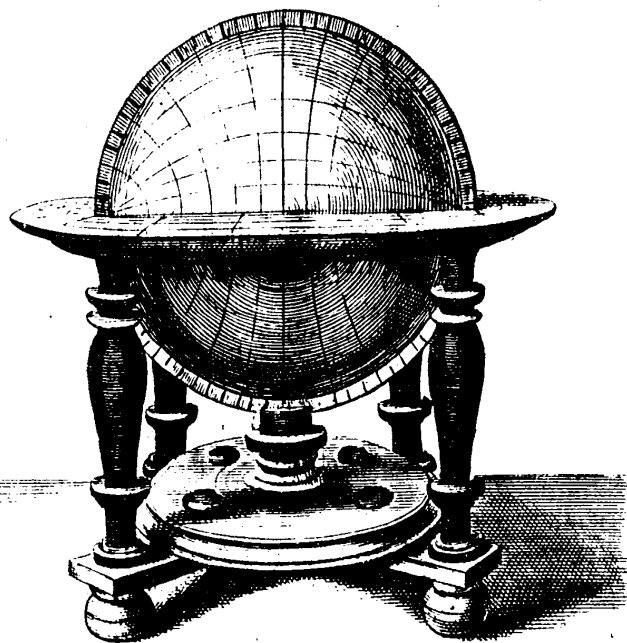
Furthermore, in respect of the *Horizon*, we find the *Sphere* constituted into a threefold Position: as first into a *Direct Sphere*, Secondly a *Parallel Sphere*, Thirdly an *Oblique Sphere*.

A *Direct Sphere* hath both the *Poles* of the *World* in the *Horizon*, and the *Equinoctial* transiting the *Zenith*. In a *Direct Sphere* all the *Circles* parallel to the *Equator* make right Angles with the *Horizon*, and are also divided into two equal parts by the *Horizon*: and in a *Direct Sphere* the *Sun*, *Moon*, and *Stars* are always twelve Hours above the *Horizon*, and twelve Hours under the *Horizon*, and consequently make twelve Hours Day, and twelve hours Night.

It is called a *Direct Sphere*, because all the *Celestial Bodies*, as *Sun*, *Moon*, and *Stars*, &c. By the *Diurnal Motion* of the *Primum Mobile*, ascend directly Above, and descend directly Below the *Horizon*.

They that Inhabit under the *Equator* have the *Sphere* thus posited; as in the Island *Borneo*, *Sumatra*, *Celebes*, *St. Thomas*, a great part of *Africk*, *Pern* in the *West-Indies*, &c. as you may see.

see by the *Globe* it self; if you move the *Brazen Meridian* through the notches in the *Horizon*, till the *Poles* thereof touch the *Horizon*. As in the Figure.



Parallel Sphere.

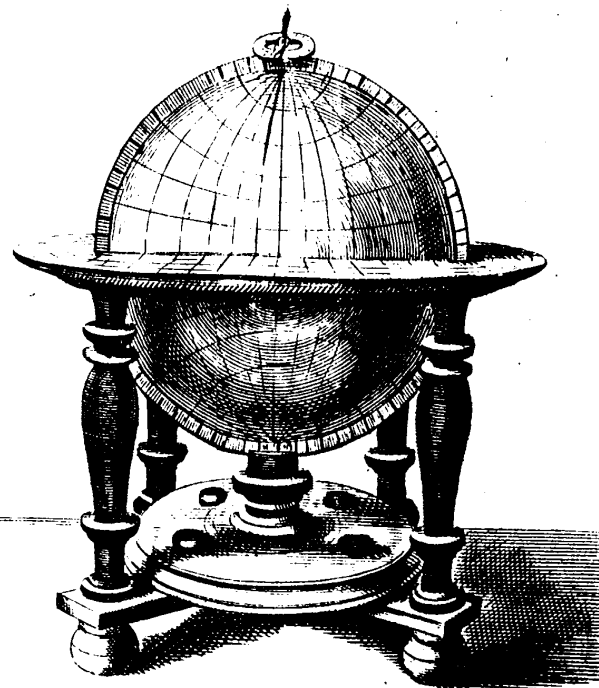
A *Parallel Sphere* hath one *Pole* of the *World* in the *Zenith*, the other in the *Nadir*, and the *Equinoctial* Line in the *Horizon*.

In a *Parallel Sphere* all the Circles Parallel to the *Equinoctial* are also Parallel to the *Horizon*, and in a *Parallel Sphere* from the 10th of *March* to the 13th of *September* (the *Sun* being then in the *North*erly *Signs*, and consequently on the *North* side the *Horizon*) there is six Months *Day* in the *North*, and six Months *Night* in the *South*; and contrarily from the 13 of *September* to the 10 of *March* (the *Sun* being then in the *South*erly *Signs*, and therefore on the *South* side the *Horizon*) there

there is six Months *Day* in the *South*, and six Months *Night* in the *North*.

It is called a *Parallel Sphere*, Because the *Sun*, *Moon*, or *Stars* in a *Diurnal* Revolution of the *Heavens*, neither ascend Higher or descend Lower, but always move parallel to the *Horizon*.

The *Earth* is thus posited under both the *Poles*, viz. in 90 Degrees of *Latitude*; as may be seen by the *Globe*, if you turn the *Brazen Meridian* till either of the *Poles* be elevated 90 Degrees above the *Horizon*. As in this Figure.



An *Oblique Sphere* hath the *Axis* of the *World* neither *Di-* Oblique Sphere. rect nor *Parallel* to the *Horizon*, but lies aslope from it.

In an *Oblique Sphere* all the *Celestial* Bodies, as *Sun*, *Moon*, or *Stars*, &c. have (in respect of the *Horizon*) oblique and unequal *Ascensions* and *Descensions*, and all the *Lines* parallel to the *Equator*



*Equator* make unequal Angles with the *Horizon*, and are cut by the *Horizon* into unequal parts; for those Lines towards the elevated *Pole*, have a greater portion of a Circle under the *Horizon* than above it: only the *Equator* because it hath the same Center with the *Horizon*, doth divide the *Horizon* into two equal parts, and is also divided into two equal parts by the *Horizon*.

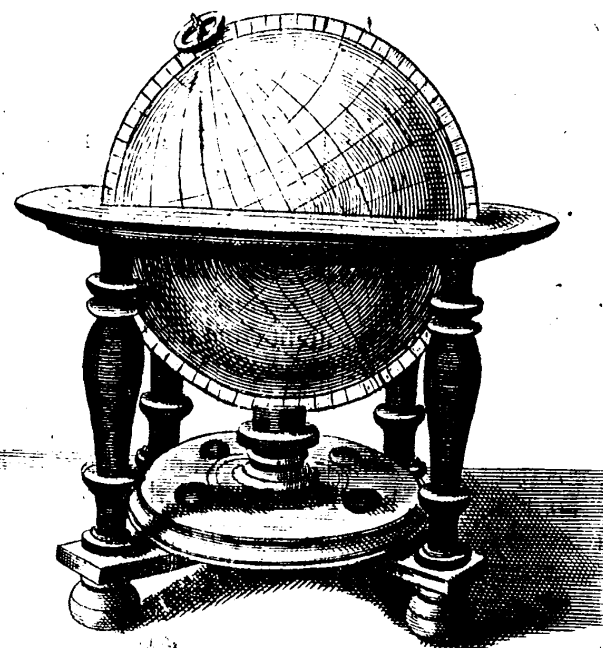
Hence it follows, that when the *Sun* is in any part of the *Ecliptick* that declines towards the elevated *Pole*, the Days in the elevated *Hemisphere* shall be Longer than the Nights: and when the *Sun* is in any part of the *Ecliptick* that Declines towards the Depressed *Pole*, the Nights shall be Longer than the Days. But when the *Sun* is in the *Equinoctial* (because whether the *Pole* be Raised or Depressed) equal portions remain both above and under the *Horizon*; therefore the Days are of the same Length with the Nights, and the Nights with the Days.

Also in an *Oblique Sphere*, all those *Stars* that have as great or greater number of Degrees of Declination than is the elevated *Poles* Complement of *Latitude* to 90, never Set or come under the *Horizon*, and those *Stars* that have the same Declination about the Depressed *Pole*, never Rise.

It is called an *Oblique Sphere*, because all the Circles of the Sphere move Obliquely about the *Horizon*.

The *Earth* is thus obliquely posited to all those Nations that Inhabit under any Degree of *Latitude*, either North or Southwards between the *Equator* and either *Pole*: as may variously be seen by the *Globe*, when the *Axis* lies not on the *Horizon*, nor the *Equator* is parallel to the *Horizon*: As in this following Figure.

Moreover



Moreover, all Places have their *Antipodes*, *Periæci* and *Antæci*.

The *Antipodes* of any Place is the opposite Degree on the *Globe*. As if a Perpendicular were let fall from the Place you stand on, through the Center of the *Earth*, and continued till it pass quithrough the Superficies of the *Earth*, on the other side; then in the point where the Perpendicular cuts the Superficies of the *Earth* on the other side, is the *Antipodes* of that Place.

The Inhabitants of any two Places that are in *Antipodes* to each other, go with their Feet directly against one another, and have a contrariety in the *Seasons* of the Year, and *Risings* and *Settings* of the *Sun*, *Moon*, or *Stars*, and all other of the *Heavenly* Bodies: so that when with Us it is *Spring*, with Them it is *Autumn*; when with Us the *Sun* Rises, in our *Antipodes* it Sets; and therefore their *Morning* is our *Evening*, their *Noon* our *Midnight*.



night, their Evening our Morning; and their Longest Day our Shortest.

The *Periaci* of any Place is that point in the same Parallel which comes to the *Meridian* with the *Antipodes*.

In the *Periaci* of any Place there happens not that Contrariety of *Seasons* in the Year that doth in the *Antipodes*; nor in the Length of Days: for the Days in both places are of equal Length: but in the Times of the Day, there is the same contrariety, for (though their *Spring* be our *Spring*) and the rest of their *Seasons* of the Year the same with ours, yet) their Morning is our Evening, their Night our Day, &c.

The *Antaci* of any Place is the point under the same *Meridian* that is distant from the *Equator* on the South side so many Degrees as your Place is distant from the *Equator* on the North side: and the contrary.

In the *Antaci* there happens not that contrariety in the Days as doth in the *Antipodes*, but in the *Seasons* of the Year there is the same contrariety; for in our *Antaci* their Morning is our Morning, their Noon our Noon, their Night our Night: but herein is the difference, their *Spring* is our *Fall*, their *Summer* our *Winter*, &c. and their Longest Day our Shortest: as in the *Antipodes*.

The

## The SECOND BOOK:

Shewing the Practical Use of the

# GLOBES.

Applying them to the Solution of Astronomical and Geographical Problemes.

## P R Æ F A C E.

Some Advertisements in Choosing and Using the GLOBES.

1. SEE the Papers be well and neatly pasted on the Globes: which you may know, if the Lines and Circles described thereon meet exactly, and continue all the way even and whole: the Lines not swerving out or in, and the Circles not breaking into several Arches; nor the Papers either come short, or lap over one the other.

2. See that the Colour be transparent, and by not too thick on the Globe; lest it hide the Superficial Descriptions.

3. See the Globe Hang evenly between the Meridian and Horizon; not inclining more to the one side than the other.

4. See the Globe Swim as close to the Meridian and

Horizon as conveniently it may; lest you be too much puzzled to find against what point of the Globe any Degree of the Horizon or Meridian is.

5. See the Equinoctial Line be one with the Horizon, when the Globe is set in a Parallel Sphere.

6. See the Equinoctial Line cut the East and West point of the Horizon, when the Globe is set to an Oblique Sphere.

7. See the Degrees of the Meridian marked with 90 and 00, Hang exactly over the Equinoctial Line of the Globe.

8. See that exactly half the Meridian be above the Horizon, and half under the Horizon: which you may know if you bring any of the Decimal Divisions to the North side of the Horizon, and find their Complement to 90 in the South.

9. See that when the Quadrant of Altitude is placed at the Zenith, the beginning of the Graduations reach just to the Superficies of the Horizon.

10. See that while the Index of the Hour Circle (by the motion of the Globe) passes from one Hour to the other, 15 Degrees of the Equator pass through the Meridian.

11. If you have a Circle of Position, see the Graduations agree with those of the Horizon.

12. See that your Wooden Horizons be made substantial and strong; for (besides the Inconveniencies that thin Wood is subject unto, in respect of warping & shrinking) I have had few Globes come to mending that have not had either broken Horizons, or some other notorious fault, occasioned through the sleightness of the Horizon.

In the Using the Globes.

**K**eepe the East side of the Horizon always towards you, unless your Proposition requires the turning of it: which East side you may know by the word East, placed

ced on the outmost verge thereof. For then have you the graduated side of the Meridian always towards you, the Quadrant of Altitude before you, and the Globe divided into two equal parts.

So oft as I name to, at, of or under the Meridian, or Horizon, I mean the East side of the Meridian, and Superficies of the Horizon: because the East side of the Meridian passes through the North and South points, both of the Globe and Horizon; and agrees just with the middle of the Axis: And the Superficies of the Horizon divideth the Globe exactly into two equal parts.

If you happen to use the Globes on the South side the Equator, you must draw the Wyes out of either Pole, and change them to the contrary Poles; putting the longest Wye into the South Pole. And because on the other side the Equator the South Pole is elevated, therefore you must elevate the South Pole of the Globe above the Horizon, according to the South Latitude of your Place; as shall be shewed hereafter.

In the working some Problems it will be required that you turn the Globe to look on the West side thereof: which turning will be apt to jog the Ball, so as the Degree that was at the Horizon or Meridian, will be moved away, and thereby the Position of the Globe altered: To avoid which inconvenience you may make use of a Quill, thrusting the Feather end between the Ball and the Brazen Meridian, and so wedge it up, without wronging the Globe at all, till your Proposition be answered.

#### P R O B. I.

To find the Longitude and Latitude of Places on the Terrestrial Globe.

**S**eeke the Place on the Terrestrial Globe, whose Longitude and Latitude you would know, and bring that Place to the Brazen

*Brazen Meridian*; and see how many Degrees of the *Equator* is cut by the *Meridian*, from the First general *Meridian* (which on my *Globes* pass through *Gratiosa*, one of the *Isles* of the *Azores*) for that number of Degrees is the *Longitude* of the *Place*.

### Example.

I desire to know the *Longitude* of *London*, and close to the name *London* I find a small mark o thus (which small mark is in some *Globes* and *Maps* adorned with the Picture of a Steeple, &c.) therefore I do not bring the word *London* to the *Meridian*, but that small mark; for that always represents the Town or City sought for: And keeping the *Globe* steady in this Position, I examine how many Degrees of the *Equator* are contained between the *Brazen Meridian*, and the first general *Meridian*; which I find to be 27 Deg. 15. min. Therefore I say the *Longitude* of *London* is 27 Deg. 15 min.

### For the Latitude.

See on the *Brazen Meridian* how many Degrees are contained between the *Equator* and the mark for *London*, which in this Example is  $51\frac{1}{2}$ ; therefore I say *London* hath  $51\frac{1}{2}$  North *Latitude*.

## P R O B. II.

*The Longitude and Latitude being known, to Rectifie the Globe fit for Use.*

1. **W**hen you Rectifie the *Globe* to any particular *Latitude*, you must move the *Brazen Meridian* through the notches of the *Horizon*, till the same number of Degrees accounted on the *Meridian* from the *Pole* (about which the *Hour Circle* is) towards the *North* point in the *Horizon* (if in *North Latitude*, and toward the *South* if in *South Latitude*) come just to the edge of the *Horizon*.

### Example.

By the former Proposition I found the *Latitude* of *London* to be

be  $51\frac{1}{2}$  Degrees *North Latitude*: therefore I count  $51\frac{1}{2}$  Degrees from the *Pole* downwards towards my right Hand, and turn the *Meridian* through the Notches of the *Horizon* till those  $51\frac{1}{2}$  Degrees come exactly to the uppermost edge of the *North* point in the *Horizon*; and then is the *Meridian* rectified to the *Latitude* of *London*.

2. Next Rectifie the *Quadrant of Altitude*, after this manner. Screw the edge of the *Nut* that is even with the Graduated edge of the thin Plate, to  $51\frac{1}{2}$  Degrees of the *Brazen Meridian*, accounted from the *Equinoctial* on the *Southern* side the *Horizon*, which is just the *Zenith* of *London*: and then is your *Quadrant* Rectified.

3. Bring the Degree of the *Ecliptick* the *Sun* is in that Day to the *Meridian*: which you may learn to know by the next Probleme, and then turn the *Index* of the *Hour Circle* to the Hour 12. on the *South* side the *Hour Circle*, and then is your *Hour Circle* also Rectified fit to use for that Day.

4. Lastly, If you will Rectifie the *Globe* to correspond in all respects with the Position and Situation of the *Sphere*; you must set the four Quarters of the *Horizon*, viz. *East*, *West*, *North*, and *South*, agreeable with the four Quarters of the *World*; which you may do by the *Needle* in the Bottom of the *Horizon*; for you must turn the *Globe* so long till the *Needle* point just to the *Flower de Luce*. Next you must set the Plain of the *Wooden Horizon* parallel to the *Horizon* of the *World*; which you may try by setting a common *Level* to the four Quarters of the *Horizon*. And then positing the Degree of the *Ecliptick* the *Sun* is in to the Height above or Depth below the *Horizon* the *Sun* hath in *Heaven* (as by Prob. 11.) your *Globe* is made correspondent in all points with the frame of the *Sphere*, for that particular *Time* and *Latitude*.

## P R O B. III.

*To find the Place of the Sun in the Ecliptick, the Day of the Month being first known.*

**S**EEK the Day of the Month in the Circle of Months, upon the *Horizon*, and right against it in the Circle of *Signs* is the Degree of the *Ecliptick* the *Sun* is in.

### Example.

*Example.*

Imagine the Day to be given is *May 10.* therefore I seek on the *Horizon* in the Circle of Months, for *May*, and find the Months divided into so many parts as there is Days in the Month; which parts are marked with Arithmetical Figures, from the beginning of the Month to the end, and denote the number of the Day of the Month that each Division represents: therefore among the Divisions I seek for 10, and directly against it in the Circle of Signs, I find  $\varnothing$  29 Degrees. Therefore I say, *May 10.* the *Sun's* Place is in 29 Degrees of  $\varnothing$ .

But note, That if it be *Leap Year*, instead of the 10. of *May*, you must take the 11. of *May*, because *February* having in a *Leap Year* 29 Days, the 29 of *February* must be reckoned for the first of *March*; and the first of *March* for the second of *March*; the second of *March* for the third of *March*, and so throughout the Year.

The *Leap Year* is caused by the six odd Hours more than 365 Days that are assigned to every Common Year: so that in a Revolution of 4 Years, one Day is gained, which is added to *February*; and therefore *February* hath every fourth or *Leap year* 29 Days.

## P R O B. IV.

*To find the Day of the Month, the Place of the Sun being given.*

**A**S in the last Probleme it was your Task to find on the *Horizon* the Day of the Month first, so now you must first seek the Sign and Degree the *Sun* is in, and against it in the Circle of Months you shall see the Day of the Month: as against  $\varnothing$  29 you have *May 10.*

## P R O B. V.

*The Place of the Sun given to find its Declination.*

**H**AVING by the third Probleme found the *Sun's* Place on the Plain of the *Horizon*, you must seek the same Degree in the

the *Ecliptick*, on the *Globe*; then bring that Degree to the *Brazen Meridian*; and the number of Degrees of the *Brazen Meridian* intercepted between the *Equinoctial* and the Degree just over the Degree of the *Ecliptick* the *Sun* is in, is the *Declination of the Sun* for that Day; and bears its Denomination of *North* or *South*, according to its Position either on the *North* or *South* side the *Equinoctial*.

*Example.*

By the third Probleme aforesaid, of *May 10.* I find  $\varnothing$  29. the *Sun's* place; Therefore I seek in the *Ecliptick* Line on the *Globe* for  $\varnothing$  29, and bring it to the *East* side of the *Brazen Meridian*, which is the Graduated side; and over  $\varnothing$  29, I find on the *Brazen Meridian* 20 Deg. 5 Min. (numbred from the *Equinoctial*;) and because  $\varnothing$  is on the *North* side the *Equinoctial*, therefore I say, The *Sun* hath *May 10 North Declination* 20 Degrees 5 Min.

## P R O B. VI.

*The place of the Sun given, to find its Meridian Altitude.*

**T**HE *Globe* Rectified, Bring the Degree of the *Sun* to the *Meridian* (or which is all one, the Degree of the *Ecliptick* the *Sun* is in;) and the number of Degrees contained between the *Horizon* and the *Sun's* Place in the *Meridian* is the number of Degrees that the *Sun* is Elevated above the *Horizon* at Noon, or (which is all one) the *Meridian Altitude of the Sun*.

*Example.*

To know what *Meridian Altitude* the *Sun* hath here at *London*, *May 10.* I bring the *Sun's* place (found by the third Probleme) to the *Meridian*, and count on the *Meridian* the number of Degrees contained between the *Horizon* and the Degree just over the *Sun's* place; which in this *Example* I find to be  $58\frac{1}{2}$ . Therefore I say the *Sun's Meridian Altitude May 10.* is here at *London*  $58\frac{1}{2}$  Degrees.

## P R O B. VII.

*The Sun's Place given, to find the Hour of Sun Rising, and the Length of the Night and Day.*

**T**HE *Globe* and *Hour Index* Rectified, Seek the Degree the *Sun* is in on the *Globe*, and bring that Degree to the *Eastern* Side

Side of the Horizon; and the Index of the Hour Circle will point at the Hour of Sun-Rising.

*Example.*

To know the Hour of Sun-Rising here at London, May 10. The Sun's place (as before) is 29. 8 Therefore the Globe being Rectified (as before) I seek 29 Degrees on the Globe, and bring that Degree to the East side of Horizon; and looking on the Index of the Hour Circle, I find it point at 4 a Clock, and  $\frac{1}{8}$  part of an Hour more towards 5; therefore I say May 10. the Sun Rises here at London at  $\frac{1}{8}$  (which is 10 Minutes) after 4 a Clock in the Morning.

If you double 4 Hours 10 Minutes it gives you the Length of the Night, 8 Hours 20 Minutes: And if you subtract the Length of the Night 8 Hours 20 Minutes from 24 Hours, the Length of Day and Night; it leaves the Length of the Day 15 Hours 40 Minutes.

PROB. VIII.

*To find the Hour of Sun Set.*

Turn the place of the Sun to the West side of the Horizon, and the Index of the Hour Circle shews on the Hour Circle the Hour of Sun Set; which on the 10th of May aforesaid, is  $\frac{1}{8}$  parts of an Hour after 7 a Clock at Night, viz. the Sun sets at 48 Minutes past 7 a Clock.

PROB. IX.

*To find how long it is Twilight in the Morning & Evening.*

Twilight is that promiscuous and doubtful Light which appears before the Rising of the Sun in the Morning, and continues after the Setting of the Sun in the Evening: It is made by the extension of the Sun Beams into the Vapours of the Air, when the Sun is less than 18 Deg. below the Horizon: for the Sun ere it Rises, and after it sets, shoots forth its Beams through the Air, and so illuminates the Vapours of the Air, which illumination does by degrees enlighten the Horizon: and spreads through the Zenith, even in the West ere the Sun Rises; and also continues above the Horizon after the Sun Sets.

Now though it be Twilight when the Sun is 18 Degrees below the Horizon; yet the Duration of Twilight is alterable both in ref.

respect of Time and Place, for at such Time as the Sun is farthest distant from any Place, the Twilight shall be Greater, than when it is nearest. And in respect of Place, All Places that have great Latitude from the Equator, have longer Twilight than those that are nearer to the Equator: for as Authors say, under the Equator there is no Twilight; when again in many Climes both Northward and Southward, the Nights are indeed no Nights, but only (as it were) a little over-spread with an obscure Shade; and it is either increased or diminished according to the mutation of Meteorological Causes.

Therefore to know the beginning of Twilight in the Morning here at London, May 10; you must (having the Globe rectified) turn the Degree of the Ecliptick which is opposite to the Place of the Sun (viz. m. 29.) till it be elevated 18 Degrees in the Quadrant of Altitude above the Horizon in the West; So shall 29. Deg. of 8 be depressed 18. Deg. below the Horizon in the East side; and the Index of the Hour Circle point at the Hour that Twilight begins: then subtract the Hour and Minute that Twilight begins from the Hour and Minute of Sun Rising, if in the Morning; or subtract the Hour of Sun Set from the Hour of Twilight, if at Night, and the Remainder is the length of Twilight.

*Example.*

The Globe, Quadrant, and Hour-Index being Rectified, as before; and the Sun's place given 29. I seek the opposite Degree on the Globe after this manner: I bring 29. to the Meridian, and observe what Degree of the Ecliptick the opposite part of the Meridian cuts; and because I find it cuts m. 29. therefore I say m. 29. is opposite to 29. having found the opposite Degree, I bring it into the West, and also the Quadrant of Altitude, and joynt m. 29. to 18 Degrees (accounted upwards on the Quadrant) so shall 29 be depressed 18 Degrees in the East side the Horizon: Then looking what Hour the Hour-Index points at in the Hour-Circle, I find it to be 1 Hour 8 Min. which shews that Twilight begins at 8 Minutes past 1 a Clock in the Morning.

And if you subtract 1 Hour 8 Minutes, from 4 Hours 11 Minutes the Time of Sun Rising found by the 7th Probleme, it leaves 3 Hours 3 Minutes for the Length of Twilight: And if you double 1 Hour 8 Minutes, the Beginning of Twilight, it makes

makes 2 Hours 16 Minutes for the intermission of Time between *Twilight* in the Evening, and *Twilight* in the Morning; So that *May 10.* absolute Night is but 2 Hours 16 Minutes Long, here at *London*.

The reason why you bring the Degree opposite to the *Suns* place to the *West*, is, because the *Quadrant* containing but 90 Degrees will reach no lower than the *Horizon*, but this Probleme requires it to reach 18 Degrees beneath it: therefore by this Help, you have the Proposition answered; as well as if the *Quadrant* did actually reach 18 Degrees below the *Horizon*. This shift you may have occasion to make in some other Problemes.

If you would know when *Twilight* ends after the *Sun* Sets; you shall find it by bringing the Degree of the *Ecliptick* opposite to the place of the *Sun* to 18 degrees of the *Quadrant of Altitude*, on the *East* side the *Horizon*; for then shall the *Index* of the *Hour-Circle* point at 10 Hours 52 Minutes: which shews that it continues *Twilight* till 52 Minutes past 10 a Clock at Night, *May 10.* here at *London*.

#### PROB. X.

*The Suns Place given, to find its Amplitude; And also to know upon what point of the Compass it Rifeth.*

**T**He *Globe*, &c. Rectified: Bring the *Suns* place to the *East* side the *Horizon*; and the number of Degrees intercepted between the *East* point of the *Horizon* and the *Suns* place, is the number of Degrees of *Amplitude* that the *Sun* hath at its Rising; and bears its denomination either of *North* or *South*, according to its inclination to either point in the *Horizon*.

Or if you would know upon what *Point of the Compass* the *Sun* Rifeth; Look but in the *Circle of Winds*, and against the place of the *Sun* you have the name of the *point of the Compass* upon which the *Sun* Rifeth.

#### Examples of both.

*May 10.* the *Suns* place is 8 29. Therefore the *Globe* being rectified; I bring 8 29. to the *East* side the *Horizon*, and find it touch against 33 Degrees 20 Minutes from the *East* point towards the *North*: Therefore I say the *Sun* hath *North Amplitude* 33 Degrees 20 Minutes.

And

And to know upon what *point of the Compass* the *Sun* Rifeth; I keep the *Globe* to its Position, and look in the *Circle of Winds*, in the outmost Verge of the *Horizon*, and find the *Suns* place against the *Wind*, named *North East* and by *East*; Therefore I say *May 10.* here at *London*, the *Sun* Rifeth upon the *North East* and by *East* point of the *Compass*.

#### PROB. XI.

*The Day of the Month and Hour of the Day given, to find the Height of the Sun, in any given Latitude.*

**T**He *Globe*, &c. Rectified, Turn about the *Globe* till the *Index* of the *Hour-Circle* point (in the *Hour-Circle*) to the Hour of the Day; Then bring the *Quadrant of Altitude* to the *Suns* place in the *Ecliptick* and the Degree on the *Quadrant* which touches the *Suns* place, shall be the number of Degrees of the *Suns* *Altitude*.

#### Example.

*May 10.* here at *London*; At 53 Minutes past 8 a Clock in the Morning, I would know the Height of the *Sun* above the *Horizon*. Therefore I turn about the *Globe* till the *Index* of the *Hour-Circle* comes to 53 Minutes past 8 a Clock (which is almost 9) in the *Hour-Circle*: And keeping the *Globe* to this position, I bring the *Quadrant of Altitude* to the *Suns* place, viz. 8 29 (found by the third Probleme); and because the *Suns* place touches upon 40 Degrees of the *Quadrant*, therefore I say *May 10.* 53 Minutes past 8 a Clock in the Morning, here at *London*, The *Sun* is just 40 Degrees above the *Horizon*; or which is all one, hath 40 Degrees of *Altitude*.

#### PROB. XII.

*The Altitude of the Sun and Day of the Month given, to find the Hour of the Day.*

**A**N Hour is the 24th part of a Day and a Night, or the space of Time that 15 Degrees of the *Equator* takes up in passing through the *Meridian*; for the whole *Equator* which contains 360 Degrees, passes through the *Meridian* in 24 Hours, therefore 15 Degrees which is the 24th part of 360 pass through in one Hour. These Hours are vulgarly divided into Halfs, Quarters,

ters and Half quarters; but Mathematically into Minutes, Seconds, Thirds, Fourths, &c. A Minute is the 60 part of an Hour; so that 60 Minutes make an Hour; 30 Half an Hour; 15 a Quarter of an Hour: A Second is the 60 part of a Minute: a Third is the 60 part of a Second: A Fourth is the 60 part of a Third: and so you may run on to Fifths, Sixths, Sevenths, &c. if you please: 12 of these Hours make a Day, and 12 more make a Night: so that Day and Night contain 24 Hours, as aforesaid; which are vulgarly numbred from Noon, with 1, 2, 3, to 12, at Night: and then begin again with 1, 2, 3, till 12, at Noon: But by *Astronomers* they are numbred from Noon with 1, 2, 3, &c. till 12 at Night; and so forward to 13, 14, 15 till 24, which is just full Noon the next Day. Yet in this Treatise I shall mention the Hours as they are vulgarly counted, viz. from 1 Afternoon, till 12 at Night, and call the Hours after Midnight by 1, 2, 3, 4, &c. in the Morning, to 12 at Noon again, the next Day. But to the Operation.

The *Globe*, &c. Rectified. Bring the place of the *Sun* to the number of Degrees of *Altitude*, accounted upon the *Quadrant* of *Altitude*, and the *Hour-Index* shall point at the Hour in the *Hour-Circle*: yet herein respect must be had to the Fore or Afternoons *Elevation*; as shall be shewed in the next Probleme.

#### Example.

May 10. The *Sun* is Elevated 40 Degrees above the *Horizon*, here at *London*: Therefore having found the place of the *Sun*, by the third Probleme, to be 8 29. I move the *Globe* and *Quadrant* till I can joyn the 29th Degree of 8 to the 40th Degree upon the *Quadrant* of *Altitude*; and then looking on the *Hour-Circle*, I find the *Index* point at 53 Minutes past 8 a Clock, for the Forenoon *Elevation*; and at 3 Hours 7 Minutes for the Afternoons *Elevation*. Therefore if it be Forenoon, I say it is 53 Minutes past 8 a Clock in the Morning. But if it be Afternoon, I say it is 7 Minutes past 3 a Clock in the Afternoon.

#### To find the Hour of the Day if the *Sun* Shines.

This the Right Honourable the Earl of Castlemain has hinted in § 1. Oper. 10. of his Book intituled *The English Globe*: The manner is thus, Rectify the *Globe* to correspond in all respects with the Situation of the Sphere, as by *Prob. 2.* of this

this Book; So shall the shadow of the *Axis* (between the 10th of *March* and the 13th of *Sept.*) lye upon the Hour of the Day in the *Hour-Circle*. But to find the Hour the other half Year, you must, keeping the *Horizon* still in its position, turn the *North-Pole* of the *Globe* till it be depressed under the *Horizon* on the *South* side, so many Degrees as before it was Elevated on the *North* side; So shall the *North-Pole* be directly oppositeto its first Position, and the shadow of the *Axis* lye on the Hour of the Day in the *Hour Circle*.

### PROB. XIII.

#### How to know whether it be Before or After Noon.

HAVING made one Observation, you must make a second a little while after the first; and if the *Sun* increase in *Altitude* it is before Noon: but if it decrease in *Altitude*, it is after Noon.

#### Example.

The *Sun* was at 8 Hor. 53 Min. Elevated 40 Degr. above the *Horizon*: a little while after (suppose for examples sake a Quarter of an Hour) viz. at 9 Hor. 8 Min. I observe again the Height of the *Sun*, and find it 42 Degrees High; so that the *Altitude* is increased 2 Degrees; Therefore I say, it is Forenoon: But if the *Sun* had decreased in *Altitude*, I should have said, It is Afternoon.

#### How to take *Altitudes* by the Quadrant, Astrolabe, and Cross-staff.

There are divers Instruments whereby *Altitudes* may be taken: but the most in use are the *Quadrant*, *Astrolabe*, and *Cross-staff*. A *Quadrant* is an Instrument comprehended between two straight lines making a right Angle, and an Arch.



Arch described upon the Right Angle, as on the Center, containing 90 Degrees, which is a quarter of a Circle: and therefore the Instrument is called a *Quadrant*. See this Figure.



A represents the Center, upon which is fastned a Plumb-line, A.B. the one side, A.C. the other side, upon which the *Sights* are placed: B.C. the Arch or *Quadrant*, which is divided into 90 equal parts, and numbred from B. to C; D one *Sight* E the other *Sight*: F the *Plumbet* fastned to the *Plumb-line*.

When by this Instrument you would Observe the Height of the *Sun*, you must turn the Center A to the *Sun*, and let the Beams thereof dart in at the hole in the first *Sight* D, through the hole in the Second *Sight* E; so shall the *Plumb-line* lye upon the Degree in the *Limb* of the *Sun*'s Elevation: As if the *Plumb-line* lye upon the 20th Degree, then shall the Altitude be 20 Degrees; if on 25, the Altitude shall be 25 Degrees: and for any number of Degrees the Thred or *Plumb-line* lies on, the same number of Degrees is the Altitude of the *Sun*.

But

But if it be a *Star* whose *Altitude* you would Observe; you must hold up the *Quadrant*, and joyn the *Limb* to your Cheek-bone, and turn the Center towards the *Star*: then winking with one Eye, look through the Holes of the *Sights* with the other Eye, till you can see the *Star* through those Holes; so shall the *Plumb-line* (as before in the *Sun*) hang upon the Degree in the *Limb* of the *Stars* Elevation.

Another sort of *Quadrants* is made with a moveable *Index*, as is represented in this Figure.



A is the Center, A B and A C the two sides, B C the *Limb*, D E two *Sights* fixed upon a moveable *Index* or *Label*; F G two other *Sights* for Observing the *Horizon*.

When by this *Quadrant* you would observe an *Altitude*, the side B A must parallel to the *Horizon*, and the *Index* must be moved till the Object (be it either the *Sun*, *Moon*, or any *Star*) be seen through the Holes or Slits of the *Sights* placed on the *Index*; for then the Arch DB shall be the Elevation required. You may

H



may know when the side B A is parallel to the *Horizon*, by Observing the parting of *Heaven* from the *Earth* through the *Sights* of the Side B A.

### To take Altitudes with the Astrolabe.

The *Astrolabe* is a round Instrument flat on either side, upon one of the flats or plains is described a Circle, as B C D E, divided into 360 equal parts or Degrees, numbred from the Line of Level B A C, with 10, 20, &c. to 90. in the perpendicular D C. Upon the perpendicular is fastned a Ring, as F, so as the Instrument hanging by it, the Line of Level may hang parallel to the *Horizon*: Upon the Center is a Moveable Label or Ruler, as G H, whereupon is placed two *Sights*, as I K.



If you desire further instructions for making this Instrument, you may peruse Mr. Wright in his *Divisjon of the whole Art of*

of *Navigation*, annexed to his *Correction of Errors*: where he also shews the Use of it at large; which in brief is as follows.

You must hold the *Astrolabe* by the Ring in your left hand, and turning your right side to the *Sun*, lift up the Label with your right hand, till the Beams of the *Sun* entring through the Hole of the uppermost *Vane* or *Sight*, doth also pierce through the Hole in the nethermost *Vane* or *Sight*; and the Degree and part of Degree that the Label lies on is the height of the *Sun* above the *Horizon*.

But if it be a Star you would observe, you must use the *Astrolabe* as you were directed to use the *Quadrant*, holding it up to your Cheek-bone, and looking through the *Sights*, &c.

### To take Altitudes with the Cross-Staff.

This Instrument consists of a *Staff* about a Yard long, and three quarters of an Inch square: Upon it is fitted a *Vane* (or sometimes two or three) so as it may slide pretty stiff upon the *Staff*, and stand at any of the divisions it is set to.



The making is taught by Mr. *Wright* aforesaid: But the use is as follows.

You must put that end of the *Cross-Staff* which is next 90 Degrees to your Cheek-bone, upon the outer corner of your Eye, and holding it there steddy, you must move the *Vane* till you see the *Horizon* joyned with the lower end thereof, and the *Sun* or *Star* with the higher end; then the Degree and part of Degree which the *Vane* cutteth upon the *Staff*, is the Height of the *Sun* or *Star*.

Some of these ways for taking *Altitudes* have been formerly taught by others that have treated upon the *Use of Globes*: and therefore because some would be apt to think this Treatise uncomplete if I did not shew these ways also, I have thought fit to insert them: Yet the same things may be performed by the *Globe* alone, without troubling your self with multiplicity of Instruments; if your *Globe* be made with a hollow *Axis*; for then if the *Globe* stand *Horizontal*, you shall by Observing the Object through the *Axis* have the Degree of *Elevation*, noted by the Superficies of the *Horizon*.

## P R O B. XIV.

To Observe with the Globe the Altitude of the Sun.

Place the *Globe* so that the upper Plain of the *Horizon* may stand parallel to the Plain of the *Horizon* of your Place; as was taught by the Second Probleme; then turn the *North Pole* towards the *Sun*, and place it higher or lower, by moving the *Meridian* through the Notches of the *Horizon*, till the Beams of the *Sun* pierce quite through the *Axis* of the *Globe*: So shall the Arch of the *Meridian* comprehended between the *Pole* and the edge of the *Horizon*, be the number of Degrees that the *Sun* is elevated above the *Horizon*.

## Example.

March 20. just at Noon, here at *London*, I would Observe the *Meridian Altitude* of the *Sun*. Therefore placing the *Horizon* *Horizontal*, as by the Second Probleme: I turn the *North Pole*

*Pole* towards the *Sun*, and move it with the *Meridian* upwards or downwards, either to this side or that, till I can fit it to such a position that the *Sun-Beams* may dart quite through the hollow *Axis* of the *Globe*; which when it does, I look on the *Meridian*, and find 42 Degrees 25 Min. comprehended between the *Pole* and the Superficies of the *Horizon*: Therefore I say the *Meridian Altitude* of the *Sun* March 20. here at *London*, is 42 Degrees 25 Min.

## P R O B. XV.

To find the Elevation of the Pole, by the Meridian Altitude of the Sun, and Day of the Month given.

The Day of the Month is *March* 20. By the 4<sup>th</sup> Prob. you may find the place of the *Sun* to be  $\gamma$  10. Therefore bring the place of the *Sun* to the *Meridian*, and Elevate it above the *Horizon* the same number of Degrees it hath in Heaven; so shall the Arch of the *Meridian* comprehended between the *Pole* and the *Horizon*, be the Elevation of the *Pole* in your Place.

## Otherwise.

The Day of the Month given is *March* 20. so that by the fourth Prob. you have the *Sun's* place  $\gamma$  10; and by the fifth, the *Declination* of the *Sun*  $3.55$ . North: therefore the *Declination* being North, and you on the North side the *Equator*; you must subtract  $3.55$ . from the *Meridian Altitude*  $42.25$ . and there remains  $38.30$ . for the Height of the *Equinoctial* above the *Horizon*: But if your *Declination* had been South, you must have added  $3.55$ . to the *Meridian Altitude*, and the Sum would have been the Elevation of the *Equinoctial*. Having the Elevation of the *Equinoctial*, you may easily have the Elevation of the *Pole*; for the one is always the Complement of the other to 90. Thus the Height of the *Equinoctial*  $38.30$ . subtracted from 90, leaves  $51.30$ . for the Elevation of the *Pole*, here at *London*. And thus it follows, That the Latitude of any Place from the *Equinoctial*, is always equal to the Elevation of the

the *Pole*: for between the *Zenith* and the *Equinoctial* is contained the Complement of the Height of the *Equinoctial* above the *Horizon* to 90.

## P R O B. XVI.

*To take the Altitude of any Star above the Horizon, by the Globe.*

**T**He *Horizon* of the *Globe* set parallel to the *Horizon* of the *World*, as before: Turn the *North Pole* towards the *Star*, and when you can see the *Star* through the *Axis*, the *Northern Notch* of the *Horizon* will cut the Degree of *Elevation* on the *Meridian*.

*Example.*

April 19. at 11 a Clock at Night, I would Observe the *Altitude* of *Spica Virgo*. Therefore I let the *Horizon* parallel to the *Horizon* of the *World*, as by the Second Probleme, and turn the *Northern Pole* till it point towards the *Star*: Then looking in at the *South Pole* of the *Globe* through the *Axis*, I shall see the *Star*, and have on the *Meridian* the Question resolved. But if it point not exactly, then I move the *North Pole* either upwards or downwards to the right or to the left Hand, according as I may find occasion, till I can see the *Star* through the *Axis*; and then the edge of the *Notch* in the *Horizon* cuts 28 Degrees 59 Min. on the *Brazen Meridian*. Therefore I say April 19. at 11 a Clock at Night, here at *London*, the *Altitude* of *Spica* is 28 Degr. 59 Min. above the *Horizon*.

## P R O B. XVII.

*By the Meridian Altitude of any Star given, to find the Height of the Pole.*

**J**Oyn the *Star* to the *Meridian*, and place it to the *Altitude* Observed; so shall the number of Degrees intercepted between the *Pole* and the *Horizon*, be the *Elevation* of the *Pole*.

*Example.**Example.*

*Spica Virgo* is observed to have 28 Degr. 59 Min. *Meridian Altitude*; therefore I bring *Spica Virgo* to the *Meridian*, and Raise it or Depress it higher or lower as I find occasion, till it is just 28 Degr. 59 Min. above the *Horizon*: Then I count the number of Degrees between the *Pole* and the *Horizon*, and find them 51½. Therefore I say the *Elevation* of the *Pole* is here at *London* 51½. Yet note, If the *Star* whose *Altitude* you Observe have fewer number of Degrees of *Declination* from the *Pole* than the *Elevation* of the *Pole*, you may be apt to mistake in its coming to the *Meridian*; for those *Stars* never set; and therefore are twice visible in the *Meridian* in 24 Hours; once above the *Pole*, and once under the *Pole*.

If your *Star* have greater *Altitude* than the *North Star*, it is Above the *Pole*; but if it have less, it is Below the *Pole*: so that if you know but whether it be Above or Below, it is enough; for so you may accordingly Raise it to the *Altitude* on the *Meridian* it hath in *Heaven*, and joyn it to the *Meridian* either Above or Beneath the *Pole*, as the *Star* is placed in *Heaven*: and then the Arch of the *Meridian* comprehended between the *Pole* and the *Horizon*, is the *Elevation* of the *Pole*, as aforesaid.

*Otherwise.*

Having the *Meridian Altitude* of the *Star*, you must find its *Declination* by the 27 Problem: and if the *Declination* be *South*, and you on the *North* side the *Equator*, you must add the *Declination* to the *Meridian Altitude*, and the Sum of both makes the *Altitude* of the *Equinoctial*: But if the *Declination* be *North*, and you on the *North* side the *Equator*, you must Subtract the *Declination* from the *Meridian Altitude* (as was taught by the 15 Prob. in the *Example* of the *Sun*) and the Remainder is the *Altitude* of the *Equinoctial*. Then (as was taught by the 15 Prob. aforesaid) Subtract the *Altitude* of the *Equinoctial* from 90. the Remainder is the *Elevation* of the *Pole* in your Place.

*Example.*

*Example.*

By the last Probleme the *Meridian Altitude* of *Spica Virgo* was 28 Degrees 5 Min. and the *Declination* of *Spica* by the 27th Probleme is found 9 Degrees 3 Min. *South*: Therefore because the *Declination* is *South*, I add 9 Degrees 3 Min. to the *Meridian Altitude*, which makes 38 Degrees 30 Min. for the *Elevation* of the *Equinoctial*: which 38 Degrees 30 Min. Subtracted from 90, leaves 51 Deg. 30 Min. for the *Elevation* of the *Pole* here at *London*.

## P R O B. XVIII.

*Another way to find the Height of the Pole by the Globe; if the place of the Sun be given: And also to find the Hour of the Day and Azimuth, and Almicanter of the Sun.*

**T**HIS must be performed by help of a *Spherick Gnomon*; which is a small *Pin* or *Needle* fixed perpendicularly into a small *Basin* with an *Hollow* concave *Bottom*; that it may stand upon the convexity of the *Globe*. Therefore the *Horizon* of the *Globe* being set parallel to the *Horizon* of the *World* (as by the second Probleme) the *Spherick Gnomon* must be set exactly upon the place of the *Sun*; and then turning the *Globe* about (upon its *Axis* either from *East* to *West*, or contrarily from *West* to *East*; or else by the *Meridian* through the *Notches* of the *Horizon*) till the *Spherick Gnomon* cast no *Shadow* on any side thereof, you have on the *Meridian* in the *North* point of the *Horizon* the number of *Degrees* that the *Pole* is elevated above the *Horizon*.

*Example.*

Imagine the four *Quarters* of the *Horizon* of the *Globe* correspond with the four *Quarters* of the *Horizon* of the *World*; and the plain of the *Horizon* of the *Globe* is parallel to the plain of the *Horizon* of the *World*: The *Sun's* place is  $\alpha$  29, which

which I find on the *Globe*, and place the *Spherick Gnomon* thereon; then at agues I move the *Globe* both on its *Axis*, and by the *Meridian* (as neer as I can) so as the *Spherick Gnomon* may cast no *Shadow*; yet if it do, and the *Shadow* fall towards the *North Pole*; then I *Elevate* the *North Pole* more till the *Shadow* falls just in the middle of its self; but if the *Shadow* fall downwards towards the *South Pole*, then I *Depress* the *North Pole*: If the *Shadow* fall on the *East* side, I turn the *Globe* on its *Axis* more to the *West*; and if the *Shadow* fall to the *West*, I turn the *Globe* more into the *East*: and the *Degree* of the *Meridian* which the *North* Point of the *Horizon* touches, is the *Degree* of the *Poles* *Elevation*: which in this *Example* is  $51\frac{1}{2}$  the *Latitude* of the *City* of *London*.

By this Operation you have also given the *Hour* of the *Day* in the *Hour-Circle*, if you keep the *Globe* unmoved: and the *Azimuth*, and *Almicanter*, if you apply but the *Quadrant of Altitude* to the place of the *Sun*, as by the 22 and 23 Problemes.

## P R O B. XIX.

*To Observe by the Globe the Distance of two Stars.*

**Y**OU must pitch upon two *Stars* in the *Meridian*, and Observe the *Altitude* of one of them first, and afterwards the *Altitude* of the other: then Subtract the *Lesser Altitude* from the *Greater*, and the *Remainder* shall be the *Distance* required.

*Example.*

*March 7. at 11 a Clock at Night here at London, I see in the Meridian the two Stars in the Foremost Wheels of the Waggon, in the Constellation of the Great Bear, called by Sea-men the Pointers (because, they always point towards the Pole-Star) Therefore to Observe the Distance between these two Stars, I first Observe (as by the last Probleme) the Altitude of the most Northern to be 77 Degrees 59 Minutes, and set down that Number of Degrees and Minutes with a Pen and Ink on a Paper, or with a piece of Chalk, or a Pencil, on a Board; and afterwards I Observe the Altitude of the other Star which is under*

der it, as I did the first, to be 83 Degrees 21 Min. and let that number of Degrees and Minutes also down, under the other number of Degrees and Minutes: Then by Subtracting the Lesser from the greater, I find the Remainder to be 5 Degrees 22 Min. which is the Distance of the two Stars in the Great Bear, called the Pointers.

### PROB. XX.

*How you may learn to give a Guess at the number of Degrees that any two Stars are distant from one another; or the number of Degrees of Altitude the Sun or any Star is Elevated above the Horizon: only by looking up to Heaven, without any Instrument.*

**B**etween the Zenith and Horizon is comprehended an Arch of a Circle containing 90 Degrees; so that if you see any Star in or near the Zenith, you may know that Star is 90, or near 90 Degrees High; and by so much as you may conceive it wants of the Zenith, so much you may guess it wants of 90 Degrees above the Horizon. By this Rule you may Guess at an Arch of Heaven containing 90 Degrees; or at an Arch of Heaven containing 45 Degrees; if by your Imagination you divide the whole Arch into two equal parts, for then shall each of them contain 45 Degrees; And if by your Imagination you divide the Arch of 90 into 3 equal parts, each Division shall contain an Arch of 30 Degrees, &c. But this way is a little too rude for Guessing at Stars Elevated but few Degrees, or for Stars, Distant but few Degrees from one another. Therefore that you may learn to guess more precisely at Distances in Heaven, you may either with a Quadrant, Astrolabe, or the Globe, find the exact Distance of any two known Stars that are but few Degrees asunder, and by a little revolving the Distance of those Stars in your fancy, you may at length so imprint their Distance in your Memory, that you may readily Guess the Distance of other Stars by the Distance of them.

#### Example.

You may find either by the Globe, Quadrant, or Astrolabe (for

(for they all agree) 3 Degrees comprehended between the first Star in Orion's Girdle, and the Last; therefore by a little considering that Distance, you may imprint it in your Fancy for 3 Degrees, and so make it applicable to other Stars, either of the same Distance or more, or less: And the Pointers (by the last Probleme) are Distant from one another 5 Degrees, and almost an half: These are always above our Horizon, and therefore may always stand as a Scale for 5 and a half Degrees; So that by these for  $5\frac{1}{2}$  Degrees, and those in Orion's Girdle for 3 Degrees, and others Observed, either of Greater or Lesser distance, you may according to your own Judgment shape a Guess, if not exactly, yet pretty near Truth, when you come to other Stars. Thus you may exercise your Fancy upon Stars found to be 10 or 15 Degrees asunder, or more, or less; and with a few Experiments of this Nature enure your Judgment to Guess at Distances, and enable your Memory to retain those Guesses.

This way of Guessing will be exact enough for finding the Hour of the Night by the Stars, for most common Uses; or the Hour of the Day, by Guessing at the Altitude of the Sun; if after you have Guessed at the Altitude, you work as was taught by Prob. 12. for the Hour of the Day: and as shall be taught in the next Probleme for the Hour of the Night.

### PROB. XXI.

*The Day of the Month and Altitude of any Star given; to find the Hour of the Night.*

**T**He Globe, Quadrant, and Hour-Index Rectified; Bring the Star on the Globe to the same number of Degrees on the Quadrant of Altitude that it hath in Heaven: So shall the Index of the Hour Circle point in the Hour-Circle at the Hour of the Night.

#### Example.

March 10. The Altitude of Arcturus is 35 Degrees above the Horizon here at London: Therefore having the Globe, Qua-

*Quadrant*, and *Hour-Index* Rectified, I bring *Arcturus* on the *Globe* to 35 Degrees on the *Quadrant of Altitude*: and then looking in the *Hour-Circle*, I find the *Index* point at 10 a Clock, which is the Hour of the Night.

## PROB. XXII.

*The place of the Sun, and Hour of the Day given; to find its Azimuth in any assigned Latitude.*

THE *Globe*, &c. Rectified to your *Latitude*; Turn the *Globe* till the *Index* of the *Hour-Circle* come to the Given Hour; and bring the *Quadrant of Altitude* to the place of the *Sun*; so shall the number of Degrees contained between the *East* or *West* point of the *Horizon*, and the Degree cut by the *Quadrant of Altitude* on the *Horizon*, be the number of Degrees of the *Sun's Azimuth*, at that Time.

## Example.

May 10. at 53 Minutes past 8 a Clock in the Morning I would know the *Azimuth* of the *Sun*: Therefore (the *Globe* being first Rectified) I turn about the *Globe* till the *Index* of the *Hour-Circle* point to 53 Min. past 8 a Clock, or which is all one, within Half a quarter of an Hour of 9; then I move the *Quadrant of Altitude*, to the Degree the *Sun* is in that Day, and there let it remain, till I see how many Degrees is contained between the *East* point, and the *Quadrant of Altitude*, which in this Example is 28 Deg. 25. Min. for the *Azimuthal* distance of the *Sun* from the *East* point towards the *North*.

## PROB.

## PROB. XXIII.

*The place of the Sun and Hour of the Day given, to find the Almucantar of the Sun.*

THE finding the *Almucantar* of the *Sun* is upon the matter the same with the *Altitude* of the *Sun*: only with this distinction, The *Almucantari* are Circles parallel to the *Horizon* described by the Degree of the *Quadrant of Altitude* upon the *Zenith* as its Center, by turning the *Quadrant* round about the *Globe* till it come again to its first place: But the *Altitude* is an Arch of the *Quadrant of Altitude* or *Vertical Circle*, comprehended between the *Horizon* and any point of the *Globe* assigned. Their Agreement consists in this; When the *Sun* or any *Star* hath any known *Almucantar*, they are said to have the same number of Degrees of *Altitude*; as if the *Sun* be in the 20th *Almucantar*, he hath 20 Degrees of *Altitude*; if in the 30th *Almucantar*, he hath 30 Degrees of *Altitude*, &c. Now because the Operation is the same for finding the *Altitude* and *Almucantar*, I shall refer you to the 11 Probleme; which shews you how to find the *Altitude* or *Height*; and by consequence the *Almucantar*.

## PROB. XXIV.

*The place of the Sun given, to find what Hour it comes to the East or West; and what Almucantar it then shall have.*

THE *Globe*, *Quadrant*, and *Hour-Index* Rectified: Bring the *Quadrant of Altitude* to the *East* point in the *Horizon*, if you would know what Hour it comes to the *East*: or to the *West* point, if you would know what Hour it comes to the *West*: Then turn about the *Globe* till the place of the *Sun* come to the *Quadrant of Altitude*; and the *Index* of the *Hour-Circle* shall point at the Hour of the Day: which on the Day aforesaid will be 7 Hor. 7 Min. in the Morning that the *Sun* cometh to the *East*, and 4 Hor. 53 Min. after Noon that the *Sun* cometh to the *West*. And if you then count the number of Degrees from the

the *Horizon* upwards on the *Quadrant of Altitude*, it will shew you the *Almicantar* of the *Sun* for that Time; which will both Morning and Evening be 25 Deg. 30 Min. as was taught by the last Probleme.

### PROB. XXV.

*To know at any time what a Clock it is in any other Part of the Earth.*

**T**He difference of *Time* is reckoned by the access and progress of the *Sun*: for the *Sun* gradually circumvolving the *Earth* in 24 Hours, doth by reason of the *Earth's* rotundity enlighten but Half of it at the same moment of *Time*; as shall be shewed hereafter: so that hereby it comes to pass, that when with us here in *England* it is 6 a Clock in the Morning, with those that have 90 Degrees of *Longitude* to the *Westward* of Us, it is yet Midnight: with those that have 180 Degrees of *Longitude* from Us it is Evening; and with those that have 90 Degrees of *Longitude* to the *Eastward*, it is Noon. So that those to the *Eastward* have their Day begin sooner than Ours: But to the *Westward* their Day begins after Ours. Therefore that you may know what Hour it is in any Place of the *Earth*, of what Distance soever it be, you must first bring the Place of your own Habitation to the *Meridian*, and the *Index* of the *Hour-Circle* to 12 on the *Hour-Circle*; Then bring the other Place to the *Meridian*, and the Arch of the *Hour-Circle* comprehended between the Hour 12 and the *Index*, is the difference in *Time* between the two Places.

#### Example.

*London* in *England*, and *Surat* in the *East-Indies*: First I bring *London* to the *Meridian*, and turn the *Index* of the *Hour-Circle* to 12; then I turn the *Globe Westward*, because *London* is *Westward* of *Surat* till *Surat* come to the *Meridian*; and see at what Hour the *Index* of the *Hour-Circle* points, which in this Example is 5 Hor. 54 Minutes: And because *Surat* lies to the *Eastward* of Us so many Degrees, therefore as was said before, their

their Day begins so much before Ours: So that when here at *London* it is 6 a Clock in the Morning, at *Surat* it will be 11. a Clock 54 Minutes; when with Us it is 12 a Clock, with them it will be 5 a Clock 54 Minutes after Noon.

If you would know the difference of *Time* between *London* and *Jamaica*; Working as before, you may find 5 Hor. 15 Min. But *Jamaica* is to the *West* of *London*; therefore Their Day begins 5 Hor. 15 Min. after Ours: so that when with Us it is Noon, with Them it will be but Three quarters of an Hour past 6 Clock in the Morning: and when with Them it is Noon, with Us it will be One quarter past 5 a Clock after Noon, &c.

Or you may yet otherwise know the difference of *Time*, if you divide the number of Degrees of the *Equinoctial* that pass through the *Meridian* while the *Globe* is moved from the First place to the Second, by 15. so shall the Product give you the difference of Hours and Minutes between the two Places: as you will find if you Try either of these Examples, or any other.

### PROB. XXVI.

*To find the Right Ascension of the Sun, or Stars:*

**T**He *Right Ascension* of any point on the *Globe* is found by bringing the point proposed to the *Meridian*, and counting in the *Equinoctial* the number of Degrees comprehended between the *Vernal Equinox* and the *Meridian*.

#### Example, for the Sun.

June 1. I would know the *Right Ascension* of the *Sun*: His place (found as by the third Probleme) is *Gemini* 20. Therefore I bring *Gemini* 20 to the *Meridian*; and then the *Meridian* cuts the *Equinoctial* in 79 Deg. 15 Min. accounted from the *Vernal* point *Aries*: Therefore I say the *Right Ascension* of the *Sun*, June 1. is 79 Deg. 15 Min.

#### Example, for a Star.

I take *Capella*, alias *Hircus*, the Goat on *Auriga's* Shoulder, and

and bring it to the *Meridian*; and find the *Meridian* cut the *Equinoctial* (counting as before from the *Vernal* point  $\gamma$ ) in 73 Degrees 58 Minutes: Therefore I say, the *Right Ascension* of *Hircus* in 73 Degrees 58 Minutes. Do the like for any other point of the *Globe* proposed.

### PROB. XXVII.

#### To find the Declination of the Sun and Stars.

THE *Declination* of any point on the *Globe* is found by bringing the point proposed to the *Meridian*, and counting the number of Degrees comprehended on the *Meridian* between the *Equinoctial* and the point proposed: and bears its Denomination of *North* or *South*, according as it is Situate on the *North* or *South* side the *Equinoctial*.

#### Example, for the Sun.

June 1. I would know the *Declination* of the *Sun*. His place found, as before, is *Gemini* 20. Therefore I bring  $\pi$  20. to the *Meridian*, and find 23 Degrees 8 Minutes comprehended on the *Meridian* between the *Equinoctial* and  $\pi$  20. and because *Gemini* is on the *North* side the *Equinoctial*; therefore I say June 1. the *Sun* hath *North Declination* 23 Degrees 8 Minutes.

#### Example, for a Star.

I take *Hircus* afore said, and bring it to the *Meridian*, and find 45 Degrees 40 Minutes comprehended on the *Meridian* between the *Equinoctial* and the *Star Hircus*. And because *Hircus* is on the *North* side the *Equinoctial*; Therefore I say, *Hircus* hath *North Declination* 45 Degrees 40 Minutes. Do the like for any other point on the *Globe* proposed.

But note: The *Right Ascension* and *Declination* of the *Sun* alters Daily; for in twelve Months he runs through every Degree of *Right Ascension*, and in three Months to his greatest *Declination*: But the *Right Ascension* and *Declination* of the *Stars* is scarce perceivable for some Years: Yet have they also an alteration of *Right Ascension* and *Declination*: For, those *Stars* that

that have but few Degrees of *Right Ascension*, will in process of *Time* have many, and those *Stars* between the *Tropick* and *Equinoctial* that have *North Declination*, will in length of *Time* have *South Declination*; and the contrary (as shall be more fully shewed hereafter): For, the *Stars* Moving upon the *Poles* of the *Ecliptick* go forwards in *Longitude* one whole Degree in  $70\frac{1}{2}$  Years (as hath been shewed before Book 1. Chap. 3. Sect. 3.) and so alter both their *Right Ascension* and *Declination*; as may be seen by this following Table of *Right Ascensions* and *Declinations* of 100 of the most eminent fixed *Stars*; Calculated by *Tycho Brahe*, for the Years 1600 and 1700, which I have inserted; partly because by it you may see the Difference of their *Right Ascensions* and *Declinations* in  $70\frac{1}{2}$  Years; and partly to accommodate those that may have occasion to know their *Right Ascensions* and *Declinations* nearer than the *Globe* can shew them.

A Table of the *Right Ascensions* and *Declinations* of 100 Select Fixed *Stars*; Calculated by *Tycho Brahe*, for the Years 1600 and 1700. As also their Difference of *Right Ascensions* and *Declinations* in 70 Years.

Names of the Stars.	1600.			Differentia.		1670.		
	R.	Afc.	Declin.	R. A.	Decl.	R.	Afc.	Declin.
Scedir, in Cassiopeæ.	4	36	54 21 N	1 22	34 S	5	58	54 55
The Pole Star. (tail.	5	47	87 9½ N	3 59	34 S	9	46	87 43½
Southern in the Whales.	5	51	20 12 S	1 17	34 N	7	8	19 38
Cassiopeæ's Belly.	8	21	58 33 N	1 27	34 S	9	48	59 7
Girdle Andromeda.	11	50	33 32 N	1 23	33 S	13	13	34 5
Knee of Cassiopeæ.	15	3	58 7 N	1 35	33 S	16	38	58 40
1. in $\gamma$ Horn.	22	56	17 19 N	1 23	31 S	24	19	17 50
Whales Belly.	22	59	12 16 S	1 15	31 N	24	14	11 45
2. in $\gamma$ Horn.	23	10	18 50 N	1 22	31 S	24	32	19 31
South Foot of Andromeda.	24	55	40 23 N	1 29	30 S	26	24	40 52



Names of the Stars.	1600.					Differentia.			1700.				
	R.	A/c.	Declin.			R.	A.	Decl.	R.	A/c.	Declin.		
In the Knot in the Line $\times$ .	25	22	0	50	N	1	18	30	S	26	40	1	29
* Star in $\gamma$ Head.	26	23	21	33	N	1	25	30	S	27	38	22	3
* In the Whales Jaw.	40	25	2	29	N	1	15	25	S	41	40	2	54
Caput Medusæ.	40	38	39	22	N	1	37	25	S	42	15	39	47
* In Perseus Side.	44	2	48	22	N	1	28	21	S	45	30	48	43
* in the Pleiades.	50	57	22	49	N	1	29	21	S	52	26	23	19
In the Nostrils of $\delta$ .	59	16	14	37	N	1	25	17	S	60	41	14	54
North Eye of $\gamma$ .	61	21	18	14	N	1	24	17	S	62	45	18	35
Aldebaran.	63	16	15	38	N	1	26	15	S	64	43	15	53
Hircus, Capella.	71	49	45	30	N	1	49	10	S	73	38	45	49
* Orions Foot, Rigel.	73	51	8	43	S	1	15	9	S	75	78	33	2
North Horn $\delta$ .	75	16	28	12	N	1	37	8	S	76	53	28	20
Orions Left Shoulder.	75	58	5	55	N	1	19	8	S	77	17	6	3
Belly of the Hare.	77	48	21	6	S	1	57		N	78	53	20	59
1. In Orions Girdle.	77	58	0	39	S	1	17	7	N	79	15	0	32
Uppermost in Orions Face.	78	21	9	36	N	1	22	7	S	79	41	0	43
South Horn $\delta$ .	78	26	20	51	N	1	31	7	S	79	57	20	58
2. In Orions Girdle.	79	1	1	30	S	1	17	6	N	80	18	1	24
Last in Orions Girdle.	80	10	2	12	S	1	16	5	N	81	26	2	7
Auriga's Right Shoulder.	82	40	44	50	N	1	55	4	S	84	35	44	54
Orions Right Shoulder.	83	26	7	16	N	1	22	4	S	84	48	7	20
* Foot II.	93	38	16	40	N	1	28	2	N	95	61	16	38
Great Dog, Sirius. (Twin.	96	53	16	11	S	1	74		S	98	0	16	15
Head of Castor, the first	107	9	32	41	N	1	44	11	N	108	53	32	30
The Little Dog, Procyon.	109	37	6	12	N	1	20	12	N	110	57	6	0
Head Pollux, second Twin.	110	13	28	55	N	1	34	12	N	111	47	28	43
* In the Stern of the Ship.	117	39	23	11	S	1	41	15	S	118	43	23	26
Præpepe $\delta$ .	124	20	21	2	N	1	28	19	N	125	48	20	43
Northern $\alpha\beta$ $\delta$ .	124	58	22	51	N	1	30	20	N	126	28	22	31
Southern $\alpha\beta$ $\delta$ .	125	27	19	35	N	1	27	20	N	126	54	19	15
The Heart of Hydra.	137	16	57		S	1	15	25	S	138	16	7	22
South of 3. in Neck $\alpha$ .	146	22	18	42	N	1	28	28	N	147	50	18	14
Lyons Heart, Basiliscus.	146	45	13	53	N	1	53	28	N	148	8	13	25
North of 3. in Neck $\alpha$ .	148	33	25	23	N	1	23	29	N	150	124	54	
Middle of 3. in Neck $\alpha$ .	149	25	21	50	N	1	50	29	N	150	51	21	21

Names

Names of the Stars.	1600.				-	Differentia.			1700.				
	R.	A/c.	Declin.			R.	A.	Decl.	R.	A/c.	Decl.		
First lowest in $\square$ Urfa Maj.	159	12	58	31	N	1	37	32	N	160	49	57	59
First upper in $\square$ Dubbe.	159	37	63	54	N	1	41	32	N	161	18	63	22
* Back $\alpha$ .	163	10	22	43	N	1	27	34	N	164	37	22	9
Lions Tail. (Major.)	172	9	16	49	N	1	19	34	N	173	28	16	15
Following lowest in $\square$ Urfa	173	3	55	57	N	1	23	34	N	174	26	55	23
Uppermost following in $\square$ .	178	50	59	15	N	1	20	34	N	180	10	58	41
Girdle $\pi$ .	188	53	5	37	N	1	18	34	N	190	11	5	3
Rump Urfa Major, Aliot.	189	1	58	10	N	1	19	33	N	190	10	57	37
Vindemiatrix, $\pi$ .	190	36	13	8	N	1	17	33	N	191	53	12	35
Spica $\pi$ .	196	49	1	1	S	1	19 $\frac{1}{2}$	32 $\frac{1}{2}$	S	197	23 $\frac{1}{2}$	9	31
Middle Tail Urfa Major.	196	54	57	3	N	1	3	32	N	197	57	56	31
End Tail Urfa Major.	202	54	51	22	N	1	2	31	N	203	56	50	51
Arcturus.	209	23 $\frac{1}{2}$	21	18 $\frac{1}{2}$	N	1	11	29 $\frac{1}{2}$	N	210	34 $\frac{1}{2}$	20	49
Left Shoulder of Bootes.	214	24	0	3	N	1	2	27	N	215	4	39	36
South Scale $\approx$ .	217	14 $\frac{1}{2}$	14	18	S	1	23	27	S	218	37 $\frac{1}{2}$	14	45
North Scale $\approx$ .	223	54 $\frac{1}{2}$	7	50	S	1	21 $\frac{1}{2}$	24	S	225	16	8	14
* Northern Crown.	229	26	28	6	N	1	5	21	N	230	31	27	45
* Serpents Neck.	231	12	7	46	N	1	15	21	N	232	27	7	25
North of 3. * in Front $\pi$ .	235	34	18	38	S	1	28	19	S	237	2	18	57
Left Hand Ophiucus.	238	25	2	37	S	1	23	18	S	239	48	2	55
Heart $\pi$ . Antares.	241	18	25	26	S	1	32	16	S	242	50	25	42
Right Shoulder Hercules.	243	15	22	27	N	1	5	15	N	244	20	22	12
Left Knee of Ophiucus.	243	49	39	3	S	1	23	15	S	245	12	9	54
Right Knee of Ophiucus.	251	50	15	7	S	0	50	10	S	252	40	15	17
Head of Hercules.	254	61	4	55	N	1	8	8	N	255	14	14	47
Left Shoulder of Hercu.	254	40	25	22	N	0	52	8	N	255	32	25	14
Head of Ophiucus.	259	5	12	56	N	1	11	7	N	260	16	12	49
Right Shoulder Ophiucus.	260	56	4	49	N	1	13	5	N	262	9	4	44
* Head of the Dragon.	266	52	51	37	N	0	35	2	N	267	27	51	35
* Lyrae.	275	52	38	28	N	0	50	4	S	276	42	38	32
Most Eastern in Head $\gamma$ .	281	32	21	35	S	1	31	8	N	283	3	21	27
Vultures Tail.	281	47	13	20	N	1	13	8	S	283	0	13	28
In the Swans Beak.	288	40	27	10	N	1	1	11	S	289	41	27	21
* in Vulture.	292	49	7	54	N	1	17	13	S	294	68		7
In the Swans North Wing.	293	10	44	12	N	0	48	14	N	293	58	44	26

K 2

Names

Names of the Stars.	1600.			Differencia.	1670.		
	R.	Asc.	Declin.		R.	Asc.	Declin.
Upper Horn $\nu$ .	289	57	13 40	S	1 25	16 N	300 22 13 24
Lower Horn $\nu$ .	299	39	15 57	S	1 27	17 N	301 6 15 40
In the Swans Breast.	302	1 $\frac{1}{2}$	39 1	N	0 53 $\frac{1}{2}$	18 S	302 55 39 19
Left Hand of $\alpha$ .	306	32	10 53	S	1 16	19 N	307 48 10 34
Swans Tail.	306	57 $\frac{1}{2}$	43 53 $\frac{1}{2}$	N	0 51 $\frac{1}{2}$	20 $\frac{1}{2}$ S	307 49 44 14
In the Swans South Wing.	307	31	32 30	N	1 02	21 S	308 31 32 51
Left Shoulder $\alpha$ .	317	37	7 15	S	1 21	26 N	318 58 6 49
1. In Tail $\nu$ .	319	28	18 21	S	1 26	26 N	320 54 17 55
In Cepheus Girdle.	320	46	68 50	N	0 22	26 S	321 8 69 16
In Pegasus Mouth.	321	10	8 5	N	1 18	26 S	322 28 8 31
2. In Tail $\nu$ .	321	16	17 51	S	1 25	27 N	322 41 17 24
Right Shoulder of $\alpha$ .	326	19	2 13	S	1 20	29 N	327 39 1 44
Fomahant, $\alpha$ .	338	46	31 39	S	1 25	31 N	340 11 31 8
Scheat, Pegasus.	241	9	25 56	N	1 12	32 S	341 11 26 28
Marchab, Pegasus.	341	15	13 5	N	1 15	32 S	342 30 13 37
Mouth of Southern Fish.	344	9	1 7	N	1 17	33 S	345 26 1 40
Head of Andromeda.	356	59	26 54	N	1 17	34 S	358 16 27 28
* Cassiopea's Chair.	357	5	56 58	N	1 15	34 S	358 20 57 32
End of Pegasus Wing.	358	14	12 58	N	1 16	34 S	359 30 13 32
Northern the Whales Tail.	359	49	11 1	S	1 18	34 S	1 7 10 27

### The Use of this Table.

The First Column on the left Hand is the Names of the Stars. The Second Column shews the Degrees and Minutes of *Right Ascension* for the Year 1600. The Third, the *Declination* for the same Year. The Fourth shews whether the *Declination* be North or South; N stands for North, S for South. The Fifth shews the Difference in Degrees and Minutes of *Right Ascension* of the Stars, between the Years 1600. and 1670. The Sixth shews the Difference of *Declination*; and whether it be North or South. The Seventh shews the *Right Ascension* in Degrees and Minutes for the Year 1670. The Eighth shews the *Declination* in Degrees and Minutes for the same Year.

By this Table you may perceive the Fixed Stars increase in *Right Ascension*, till they come to the *Vernal Colure*; from whence

whence the number of their *Right Ascension* is reckoned: and by the Column of their Difference of *Right Ascension*, you may see how much they increase in 70 Years. And if you would know how much they increase for any other number of Years, you must find what proportion they have to 70, and the same proportion the Difference of the *Right Ascension* of the Stars will have to the Difference in the Table.

### Example.

I would know the Difference of *Right Ascension* the Pole-Star will have in 35 Years. I find in the Fifth Column the Difference of *Right Ascension* of the Pole Star to be 3 Degrees 59 Minutes; Therefore by the Rule of Proportion, I say, If 70 Years give 3 Degrees 59 Minutes, 35 Years shall give 1 Degree 59 $\frac{1}{2}$  Minutes, and so proportionably for any other Number of Years.

Though this Rule serves for finding the Difference of *Right Ascension* of any Star; yet it will not serve for finding the Difference of any Stars *Declination*. For the Stars on the North side the *Equinoctial* between the *Hyemnal* and *Solstitial Colures*, and on the South side the *Equinoctial* between the *Solstitial* and *Hyemnal Colures* increase in *Declination*. But the Stars on the South side the *Equinoctial* between the *Hyemnal* and *Solstitial Colures*, and on the North side the *Equinoctial* between the *Solstitial* and *Hyemnal Colures*, Decrease in *Declination*, as you may yet more plainly see by the Globe if you bring 66 $\frac{1}{2}$  Degrees of the *Meridian* to the North side of the *Horizon*, and screw the *Quadrant of Altitude* to 66 $\frac{1}{2}$  Degrees in the *Zenith*, and *Declination* of the Pole of the *Ecliptick*; and bring the *Hyemnal Colure* to the *Meridian*, for so shall the Pole of the *Ecliptick* be joyned with the Center of the *Quadrant of Altitude*, and the *Ecliptick* with the *Horizon*; and all the Circles that the several Degrees on the *Quadrant* make in a Revolution from West to East upon the Poles of the *Ecliptick*, represent the great Revolution of every Star that each Degree on the *Quadrant* cuts. And thus demonstratively will be represented the Progress of the Fixed Stars through every Degree of *Longitude*, and by consequence the Alteration of their *Right Ascension* and *Declination*. For, Imagining that Degree of the *Quadrant of Altitude* to be the Star, which just reaches the

Star;

*Star*; you may by turning about the *Quadrant*, see how Obliquely the *Star* (or the Degree representing the *Star*) either Moves about, or cuts the *Equinoctial*, and all Circles parallel to the *Equinoctial*; and thereby Observe it some times to Incline in Motion to, and other times to Decline in Motion from the *Equinoctial*. But how long Time it will be ere the *Star* Inclines to, or Declines from the *Equinoctial*, you may know by finding the Distance of *Longitude* in Degrees it hath from either the *Solstitial* or *Hyemnal Colure*; and with respecting the foregoing Rules in its Position; you may by the *Table* in Book 1. Chap. 3. Sect. 3. satisfy your self.

### Example.

The most *Northerly Star* in the *Girdle of Orion* doth yet Decrease in *Declination*. But I would know how long it shall Decrease; Therefore by the 32 Probleme, I find the *Longitude* of that *Star* to be for the Year 1670. 77 Degrees 51 Minutes, which Subducted out of 90 (the Distance of the *Solstitial Colure* from the *Equinoctial*) leaves 12.9. for the Distance of that *Star* from the *Solstitial Colure*. Therefore by the *Table* aforesaid, I find what number of Years answers to the motion of 12 Degrees 9 Minutes. And because I cannot find exactly the same number of Degrees and Minutes in the *Table*, I take the number the nearest to it, which is 14 Degrees 10 Min. and that is the Motion of the *Ecliptick* in 1000 Years. But because this 14 Degrees 10 Minutes is 2 Degrees 1 Minute too much, I seek 2 Degrees 1 Minute in the *Table*, and the number of Years against it I would Subduct from the number of Years against 14 Degrees 10 Min. and the Remainder would be the number of Years required: But neither can I find 2 Degrees 1 Minute, therefore I must take the number of Degrees and Minutes nearest to it, which is 2 Deg. 50 Min. and that yields 200 Years; which Subducted out of 1000 leaves 800 Years. But because this is also too much by the Motion of 49 Minutes, Therefore I seek for 49 Minutes in the *Table*, and Subduct the number of Years against it from 800, and the Remainder would be the number of years required. But neither is 49 Min. in the *Table*, Therefore I take the nearest to it, which is 51 Min. and that yields 60 Years; which Subducted out of 800, leaves 740. But this is likewise too much by the

the Motion of two Minutes. Therefore I seek 2 Min. in the *Table*, but cannot find it nearer than  $2\frac{1}{2}$ , and against it I find 3 Years, which 3 Years I Subduct out of 740, and the Remainder is 737 the number of Years required. You may if you please for exactness, Subduct for the  $\frac{1}{2}$  Minutes 8 Months; so have you 736 Years 4 Months, for the Time that the most *Northerly Star* in the *Girdle of Orion* will Decrease in *Declination*, after the Year 1670, which will be till *An.Dom.* 2406. after which Time it will increase in *Declination* for 12706 Years together, till it come to have 47 Degrees 8 Minutes of *Declination*: at which Time it will be in or very near the place of the most *Southerly Star* of the *Southern Crown*; and that *Star* in its place.

And thus the *Pole Star* is now found to Increase in *Declination*, and will yet this 421 Years: after which time it will Decrease in *Declination* for 12706 Years together, till it come to be within 42 Degrees 42 Minutes of the *Equinoctial*, in the void space now between *Draco* and *Lyra*; at which time *Lyra* will be almost as near the *Pole*, as the *Pole Star* now is; and then the most proper to be the *Northern Pole Star*: And the last *Star* in the *Stalk of the Doves mouth* will be then very near the *Southern Pole*, and therefore most fit to be the *Southern Pole Star*.

### PROB. XXVIII.

*The place of the Sun or any Star given, to find the Oblique Ascension, and the Oblique Descension, in any given Latitude.*

THE *Globe* Rectified, Bring the place of the *Sun* or *Star* to the *Meridian* under the *Horizon*, and the Degree of the *Equinoctial* that comes to the *Meridian* with it under the *Horizon* is the Degree of *Right Descension*. If the *Sun* or *Star* will reach no part of the *Horizon* under the *Horizon*, they have no *Right Descension*.

### For the Oblique Ascension.

Bring the place of the *Sun* or the *Star* to the *East* side the *Horizon*, and the Degree of the *Equator* cut by the *Horizon*, is the Degree of *Oblique Ascension* of the *Sun* or *Star*.

For

*For the Oblique Descension.*

Bring the place of the *Sun* or *Star* to the *West* side the *Horizon*, and the Degree of the *Equinoctial* cut by the *Horizon* is the Degree of *Oblique Descension*. They need no *Example*.

## P R O B. XXIX.

*Any Place on the Terrestrial Globe being given, to find its Antipodes.*

Bring the given Place to the *Meridian*, so may you (as by the first Probleme) see its *Longitude* and *Latitude*; then turn about the *Globe* till 180 Degrees of the *Equator* pass through the *Meridian*; and keeping the *Globe* to this *Position*, number on the *Meridian* 180 Degrees from the *Latitude* of the given Place: and the point just under that Degree is the *Antipodes*.

*Example.*

I would find the *Antipodes* of *Cuida Real*, an Inland Town of the *West-Indies*, which lies upon the River *Parana*, an Arm of *Rio de la Plata*: Therefore I bring *Cuida Real* to the *Meridian*, and find (as by the first Probleme) its *Latitude* 23. 50. *South*; and its *Longitude* 333 Degrees: Then I turn about the *Globe* till 180 Degrees of the *Equator* pass through the *Meridian*; and keeping the *Globe* to that position, I number so many Degrees *North Latitude* as *Parana* hath *South*, viz. 23. 50. and just under that Degree I find *Lamoo*, a Town lying upon the Coast of *China*, in the Province of *Quincii*: Therefore I say *Lamoo* is just the *Antipodes* of *Cuida Real*.

*Another way.*

Bring the given Place to the *North* or *South* point of the *Horizon*, and the point of the *Globe* denoted by the opposite point of the *Horizon* is the *Antipodes* of the given Place.

PROB.

## P R O B. XXX.

*To find the Perceii of any given Place, by the Terrestrial Globe.*

Bring your given Place to that side the *Meridian* which is in the *South* Notch of the *Horizon*, and follow the *Parallel* of that Place on the *Globe* till you come to that side the *Meridian*, which is in the *North* Notch of the *Horizon*, and that is the *Perceii* of your Place.

## P R O B. XXXI.

*To find the Antecii of any given Place, upon the Terrestrial Globe.*

Bring your given Place to the *Meridian*, and find its *Latitude* by the first Probleme; If it have *North Latitude*, count the same Number of Degrees on the *Meridian* from the *Equator Southwards*; but if it have *South Latitude*, count the same number of Degrees from the *Equator Northwards*: and the point of the *Globe* directly under that number of Degrees is the *Antecii* of your Place.

## P R O B. XXXII.

*To find the Longitude and Latitude of the Stars by the Celestial Globe.*

The *Quadrant of Altitude* will reach but 90 Degrees, as was said Prob. 9. Therefore if the *Star* you enquire after be on the *North* side the *Ecliptick*; Elevate the *North Pole* 66½ Degrees above the *North* side the *Horizon*: If on the *South* side the *Ecliptick* you must Elevate the *South Pole* 66½ Degrees above the *South* side the *Horizon*: Then bring the *Solstitial Colure* to the *Meridian* on the *North* side the *Horizon*, and screw the *Quadrant of Altitude* to the *Zenith*, which will be in 23 Degrees 30 Minutes from the *Pole* of the *World*: So shall the *Ecliptick* lye in the *Horizon*, and the *Pole* of the *Ecliptick* also lye under the Center of the *Quadrant of Altitude* (as was shewed

I.

shewed

shewed Prob. 27.) Now to find the *Longitude* of any *Star*, do thus, Turn the *Quadrant of Altitude* about till the Graduated edge of it lye on the *Star*; and the Degree in the *Ecliptick* that the *Quadrant* touches is the *Longitude* of that *Star*.

*Example, For a Star on the North side the Ecliptick.*

I would know the *Longitude* of *Marchab*, a Bright *Star* in the Wing of *Pegasus*: I find it on the North side the *Ecliptick*; Therefore I Elevate the North Pole, and placing  $\odot$  on the North side the *Meridian*, I screw the *Quadrant of Altitude* to the *Zenith*, as aforesaid; then laying the Edge of the *Quadrant of Altitude* upon that *Star*, I find that the end of it reaches in the *Ecliptick* to  $\times$  18. 56. Therefore I say, the *Longitude* of *Marchab* is  $\times$  18. 56.

*For the Latitude of a Star.*

The Degree of the *Quadrant of Altitude* that touches the *Star* is the *Latitude* of the *Star*.

*Example.*

The *Globe* and *Quadrant* posited as before, I find 19 Degr. 26 Min. (accounted upwards on the *Quadrant*) to touch *Marchab* aforesaid: Therefore I say, the *Latitude* of *Marchab* is 19 Degrees 26 Minutes.

And thus by Elevating the South Pole, and placing the *Globe* and *Quadrant of Altitude* as aforesaid, I shall find *Canicula* have 15 Degrees 57 Minutes South Latitude, and 21 Degrees 18 Minutes in  $\odot$  *Longitude*.

P R O B. XXXIII.

To find the Distance between any two Places, on the Terrestrial Globe.

THIS may be performed either with the *Quadrant of Altitude*, or with a pair of *Compasses*: with the *Quadrant of Altitude*, thus: Lay the lower end thereof to one Place, and see what Degree reaches the other Place, for that is the number of

of Degrees between the two Places. If you Multiply that number of Degrees by 60, the Product shall be the number of English Miles between the two Places.

*Example.*

I would know the Distance between London and the most Easterly point of *Jamaica*; I lay the lower end of the *Quadrant of Altitude* to *Jamaica*, and extending the other end towards London, I find  $68\frac{1}{2}$  Degrees comprehended between them; Therefore I say  $68\frac{1}{2}$  is the number of Degrees comprehended between London and *Jamaica*.

If you would find the Distance between them with your *Compasses*, you must pitch one Foot of your *Compasses* in the East point of *Jamaica*, and Open your *Compasses* till the other Foot reach London; and keeping your *Compasses* at that distance, apply the Feet to the *Equinoctial Line*, and you will find  $68\frac{1}{2}$  Degrees comprehended between them, as before.

If you Multiply  $68\frac{1}{2}$  by 60 it gives 4114 English Miles.

If you Multiply it by 20 it gives 1370 English Leagues.

If you multiply it by  $17\frac{1}{2}$  it gives 1199 Spanish Leagues.

If you Multiply it by 15 it gives 1054 Dutch Leagues.

P R O B. XXXIV.

To find by the Terrestrial Globe upon what Point of the Compass any two Places are Situate one from another.

FIND the two Places on the Terrestrial Globe, and see what *Rhumb* passes through them; for that is the Point of the Compass they Bear upon.

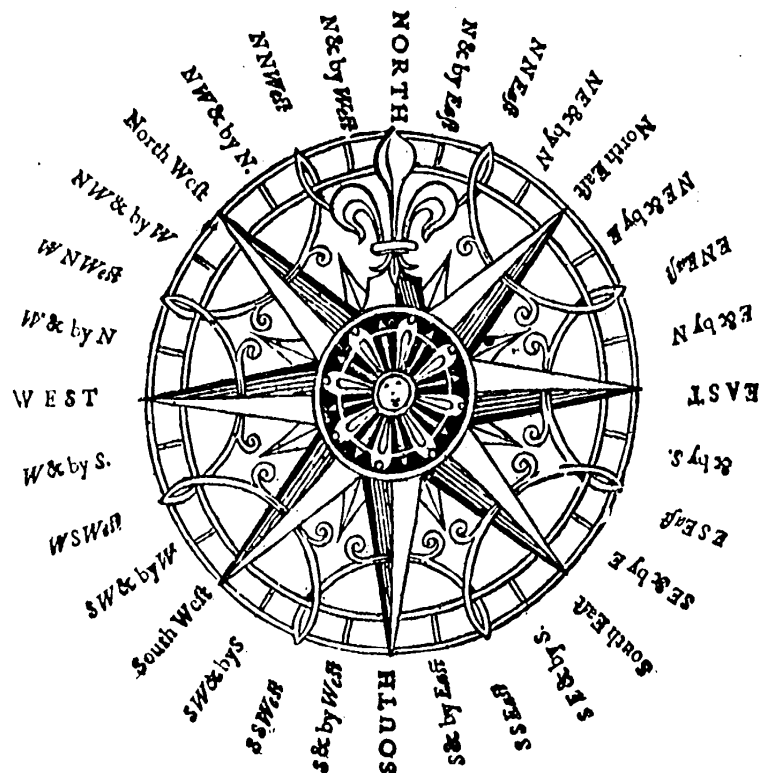
*Example.*

*Bristol* and *Bermudas* are the Places. I examine what *Rhumb* passes through them both: and because I find no *Rhumb* to pass immediately through them both, Therefore I take that *Rhumb* which runs most Parallel to both the Places; which in this Example is the Tenth *Rhumb* counted from the North towards the left Hand; and is called as you may see by this following

L 2

Figure

Figure *West South West*; Therefore I say *Bermudos* lies Situated from *Bristol West South West*; and by contraries *Bristol* lies Situate from *Bermudos East North West*.



### P R O B. XXXV.

To find by the Celestial Globe the Cosmical Rising and Setting of the Stars.

**W**hen any Star Rises with the Sun, it is said to Rise *Cosmically*.

And when any Star Sets when the Sun Rises, it is said to Set *Cosmically*.

To find these, Rectifie the Globe to the Latitude of your Place

Place, and bring the place of the Sun to the East side the Horizon; and the Stars then cut by the Eastern Semi-circle of the Horizon, Rise *Cosmically*: and those Stars cut by the Western Semi-circle of the Horizon, Set *Cosmically*.

### Example.

November 9. I would know what Stars Rise and Set *Cosmically*, here at London. The Sun's place found, as by the third Problem, is  $m\ 27$ . Therefore I bring  $m\ 27$  to the East side the Horizon, and in the Eastern Semi circle I find Rising with the Sun the Right Wing of *Cygnus*, the Star in the end of *Aquila's* Tail, *Serpentarius* and *Centaurus*: Therefore these Constellations are said to Rise *Cosmically*. In the Western Semi-circle of the Horizon I find Setting *Andromeda*, the *Triangle*, *Taurus*, *Orion*, *Canis major*, and *Argo Navis*; Therefore I say, these Constellations Set *Cosmically*.

### P R O B. XXXVI.

To find by the Celestial Globe the Acronical Rising and Setting of the Stars.

**T**he Stars that Rise when the Sun Sets, are said to Rise *Acronically*. And,

The Stars that Set with the Sun, are said to Set *Acronically*.

To find these, Rectifie the Globe to the Latitude of your Place, and bring the place of the Sun to the West side the Horizon; and the Stars that cut by the Eastern Semi-circle of the Horizon, Rise *Acronically*: And those Stars cut by the Western Semi-circle of the Horizon, Set *Acronically*.

### Example.

November 9. I would know what Stars Rise and Set *Acronically* here at London. The Sun's place as before, is  $m\ 27$ . Therefore I bring *Scorpio*  $27$  to the West side the Horizon; and in the Eastern Semi-circle I find Rising the *Southern Fish*, *Fornax*, *Cetus*, *Taurus*, *Auriga*, and the *Feather in Castor's Cap*. Therefore these Constellations are said to Rise *Acronically*. In the

the *Western* Semi-circle of the *Horizon* I find Setting the *Lyons Tail*, *Virgo*, *Scorpio*, and *Sagittarius*, Therefore I say theſe *Conſtellations* Set *Acrionically*.

## P R O B. XXXVII.

To find by the Celestial Globe the Heliacal Riſing and Setting of the Stars.

W HEN a *Star* formerly in the *Suns* Beams gets out of the *Suns* Beams, it is ſaid to *Riſe Heliacally*. And

When a *Star* formerly out of the *Suns* Beams gets into the *Suns* Beams, it is ſaid to *Set Heliacally*.

A *Star* is ſaid to be in the *Sun* Beams when it is made inconſpicuous by reaſon of its nearneſs to the *Suns* Light. The bigger *Stars* are diſcernable more near the *Suns* Light, than the leſſer are; For, *Stars* of the *First Magnitude* may (according to the received Rules of Ancient Authors) be ſeen when the *Sun* is but 12 Degrees below the *Horizon*; but *Stars* of the *Second Magnitude* cannot be ſeen unleſs the *Sun* be 13 Degrees below the *Horizon*; *Stars* of the *Third Magnitude* require the *Sun* to be 14 Degrees below the *Horizon* ere they can be ſeen; of the *Fourth Magnitude* 15 Degrees, of the *Fifth Magnitude* 16 Degrees, of the *Sixth Magnitude* 17 Degrees; the *Nebulous* ones 18 Degrees. Yet this Rule is not ſo certain, but that either Clear or Cloudy Weather may alter it. Read more of this Subject in Mr. Palmer on the *Planisphere*, Book 4. Chap. 20.

Now to find the Time that any *Star* ſhall *Riſe Heliacally*, do thus; Rectifie the *Globe* and *Quadrant of Altitude* to your *Latitude*, then bring the given *Star* to the *East* ſide the *Horizon*, and turn the *Quadrant of Altitude* into the *West* ſide, and ſee what Degree of the *Ecliptick* is elevated ſo many Degrees above the *Horizon* as the *Magnitude* of the *Star* you enquire after requires, according to the foregoing Rules; for the oppoſite Degree of the *Ecliptick* is the Degree the *Sun* ſhall be in when the *Star* Riſes *Heliacally*. Having the Degree of the *Ecliptick* the *Sun* is in, you may find the Day of the Month by the fourth Probleme.

Example.

## Example.

I would know when *Cor Leonis* ſhall *Riſe Heliacally* here at *London*; Therefore I Rectifie the *Globe* and *Quadrant of Altitude* for *London*, and bring *Cor Leonis* to the *East* ſide the *Horizon*, and turn the *Quadrant of Altitude* into the *West*; and becauſe *Cor Leonis* is a *Star* of the *First Magnitude*, therefore I ſee what Degree of the *Ecliptick* is Elevated in the *West* ſide the *Horizon* 12 Degrees on the *Quadrant of Altitude*, and find *Piſces* 9 Degrees. Now the Degree of the *Ecliptick* oppoſite to  $\times 9$ . is  $\text{m} 9$ . Therefore I ſay, When the *Sun* comes to  $\text{m} 9$  Degrees (which by the fourth Probleme I find is *Auguſt 23*.) *Cor Leonis* ſhall *Riſe Heliacally*.

## For the Heliacal Setting.

The *Globe*, &c. Rectified, as before: Bring the *Star* to the *West* ſide the *Horizon*, then ſee what Degree of the *Ecliptick* is Elevated on the *Quadrant of Altitude* on the *Eastern* ſide the *Horizon* ſo many Degrees as the *Stars* *Magnitude* requires; for when the *Sun* comes to the oppoſite Degree of the *Ecliptick* that *Star* ſhall *Set Heliacally*.

## Example.

I would know when *Bilanx* a *Star* in the *Beam* of the *Scales* will *Set Heliacally* here at *London*. The *Globe* and *Quadrant* rectified, I bring *Bilanx* to the *West* ſide the *Horizon*, and turn the *Quadrant of Altitude* into the *East*; Then I examine what Degree of the *Ecliptick* is elevated 13 Degrees of the *Quadrant of Altitude* (becauſe *Bilanx* is a *Star* of the *Second Magnitude*) and find  $\circ 4\frac{1}{2}$  oppoſite to  $\circ 4\frac{1}{2}$  is *Scorpio*  $4\frac{1}{2}$ . Therefore I ſay, When the *Sun* comes to *Scorpio*  $4\frac{1}{2}$  (which by Prob. 4. will be *October 18*.) *Bilanx* ſhall *Set Heliacally*.

## P R O B. XXXVIII.

To find the Diurnal and Nocturnal Arch of the Sun or Stars, in any given Latitude.

T H E Semi-Diurnal Arch is the number of Degrees of the *Equinoctial* that paſſes through the *Meridian* while the *Sun* or any



any *Star* is ascending above the *East* side the *Horizon* to the *Meridian*.

To know the number of Degrees it contains, Rectifie the *Globe* to the give *Latitude*, and bring the Place of the *Sun* or *Star* to the *East* side the *Horizon*, and note what number of Degrees of the *Equinoctial* is then cut by the *Meridian*: Then remove the place of the *Sun* or *Star* to the *Meridian*, & see again what number of Degrees of the *Equinoctial* is then cut by the *Meridian*, and Subtract the former from the later, and the Remainder shall be the number of Degrees of the *Sun* or *Stars Semi-Diurnal Arch*. But note, if the *Equinoctial* point  $\gamma$  pass through the *Meridian* while the *Sun* or *Star* is turned from the *East* side the *Horizon* to the *Meridian*, then you must Subtract the number of Degrees of the *Equinoctial* cut by the *Meridian* when the *Sun* or *Star* is at the *East* side the *Horizon* from 360 Deg. and to the Remainder add the number of Degrees of the *Equinoctial* that comes to the *Meridian* with the place of the *Sun* or *Star*, and the Sum of them both is the number of Degrees of the *Sun* or *Stars Semi-diurnal Arch*; which being doubled is the number of Degrees of the whole *Diurnal Arch*: and which being Subtracted from 360, gives the *Nocturnal Arch*.

#### Example of the Sun.

Having Rectified the *Globe*, I would May 10. know the *Diurnal Arch* of the *Sun*: His place found by Prob. 3. is  $8^{\circ} 29'$ . Therefore I bring  $8^{\circ} 29'$  to the *East* side the *Horizon*, and find then at the *Meridian* 299 Degr. 30 Min. of the *Equinoctial*; then I turn the place of the *Sun* to the *Meridian*, and find 56 Degr. 30 Min. of the *Equinoctial* come to the *Meridian* with it. Here the *Equinoctial* point  $\gamma$  passes through the *Meridian* while the *Sun* Moves between the *Horizon* and the *Meridian*; Therefore as aforesaid, I Subtract the First number of Degrees and Minutes, viz. 299 Degr. 30 Min. from 360 Degr. and there Remains 60 Degr. 30 Min. for the number of Degrees and Min. contained between the Degree of the *Equinoctial* at the *Meridian* and the *Equinoctial* point *Aries*; and to this 60 Degr. 30 Min. I add the Second number of Degr. and Min. viz. 56 Degrees 30 Min. the number of Degrees and Min. between the point *Aries* and the Degr. of the *Equinoctial* at the *Meridian*, and they make together 117 Degr. for the *Suns Semi-diurnal Arch*:

*Arch*: By Doubling of which you have 234 Degrees, for the *Suns Diurnal Arch*: And by Subtracting 234 (the *Diurnal Arch*) from 360, you have 126 Degrees, for the *Suns Nocturnal Arch*.

#### Example, for a Star.

I take *Sirius*, a Bright *Star* in the *Great Dogs Mouth*. The *Globe* Rectified, as before; I bring *Sirius* to the *East* side the *Horizon*, and find then 29 Degrees 30 Min. of the *Equinoctial* at the *Meridian*, then I turn *Sirius* to the *Meridian* and find 97 Degrees 38 Minutes of the *Equinoctial* Come to the *Meridian* with it: Therefore I subtract the First number, viz. 29 Degr. 30 Minutes, from the Second, 97. 38. and the Remains is 68 Degrees 8 Minutes, for the *Semi-Diurnal Arch* of *Sirius*. His *Nocturnal Arch* you may find as before.

#### PROB. XXXIX.

##### To find the Azimuth and Almucantar of any Star.

THIS Probleme is like the 22 and 23 Problemes, which shew the finding the *Azimuth* and *Almucantar* of the *Sun*; only whereas there you were directed to bring the Degree of the *Sun* to the *Quadrant of Altitude*, you must now bring the *Star* proposed to the *Quadrant of Altitude*; and by the Directions in those Problemes the Resolution will be found.

#### PROB. XL.

##### To find the Hour of the Night, by Observing two known Stars in one Azimuth or Almucantar.

RECTifie the *Globe*, *Quadrant*, and *Hour-Index*. Then find the two known *Stars* on the *Globe*; and if the two *Stars* be in one *Azimuth*, turn about the *Globe* and *Quadrant of Altitude*, till you can fit the two *Stars* to lye under the Graduated edge of the *Quadrant of Altitude*: so shall the *Index* of the *Hour-Circle* point at the Hour of the Night. If

the two Stars be in one *Almicantar*, Turn the *Globe* forward or backward till the two Stars come to such a position, that by moving the *Quadrant of Altitude*, the same Degree on it will lye on both the Stars; so shall the *Index* of the *Hour-Circle* point at the Hour of the Night.

### PROB. XLI.

*The Hour given that any Star in Heaven comes to the Meridian, to know thereby the Place of the Sun, and by consequence the Day of the Month, though it were lost.*

Bring the Star proposed to the *Meridian*, and turn the *Index* of the *Hour-Circle* to the Hour given; Then turn about the *Globe* till the *Index* point at the Hour of 12 for Noon; and the place of the *Sun* in the *Ecliptick* shall be cut by the *Meridian*.

#### Example.

March 7. at 11 a Clock at Night the *Pointers* come to the *Meridian* of London. Therefore I place the *Pointers* (on the *Celestial Globe*) under the *Meridian*, above the *Horizon*, and turn the *Index* of the *Hour-Circle* to 11 past Noon; Afterwards I turn back the *Globe* till the *Index* point to 12 at Noon; Then looking in the *Ecliptick* I find the *Meridian* cut it in *Pisces* 26 Degrees 45 Minutes; Therefore I say, when the *Pointers* come to the *Meridian* at 11 a Clock at Night, the place of the *Sun* is *Pisces* 26. 45. Having thus the place of the *Sun*, I may find the Day of the Month by the fourth Probleme; and so either know the Day that the *Pointers* come to the *Meridian* at a 11 Clock at Night, or any other Hour given.

The day of the Month might also be found by the *Declination* and the Quarter of the *Ecliptick* the *Sun* is in, given: For the *Meridian* will cut the Degree of the *Sun*s place in the *Ecliptick* in the *Parallel* of *Declination*: So that having respect to the Quarter of the *Ecliptick*, you'll find the *Sun*s place; and having the *Sun*s place, you may (as aforesaid) find the Day of the Month.

### PROB.

### PROB. XLII.

*The Day of the Month given to find in the Circle of Letters on the Plain of the Horizon, the Day of the Week.*

THE seven Days of the Week were by the Idolatry of the Ancient Roman Heathenish Times dedicated to the Honour of seven of their Gods, which we call *Planets*. The first is the most eminent, and therefore doubtless by them set in the first place, called *Dies Solis*, or the *Sun*s Day: The second *Dies Lunæ*, the *Moons* Day: The third *Dies Martis*, the Day of *Mars*: by us called *Tuesday*: The fourth *Dies Mercurii*, *Mercuries* Day: by us called *Wednesday*: from *Woden*, an Idol the Saxons worshipt, to whose Honour they dedicated that Day, and is by all those *German* Nations still called *Wodensdag*: The fifth *Dies Jovis*, *Jupiter* or *Joves* Day: which doubtless the Saxons (from whom probably we receive it) called *Donderdag*, because *Jupiter* is the God of Thunder; and we either by corruption, or for shortness, or both, called it *Thursday*: The sixth *Dies Veneris*, the Day of *Venus*: but the Saxons transferring her honour to another of their Goddesses named *Fria*, called it *Fridag*: and we from them call it *Fryday*: The seventh is *Dies Saturni*, *Saturns* Day.

The same Day of the Month in other Years happens not on the same Day of the Week, therefore the *Dominical Letter* for one Year is not the same it's the next: Now because you cannot come to the knowledge of the Day of the Week, unless you first know the *Sundays Letter*, therefore have I in Prob. 53. inserted a Table of Mr. Palmers, by which you may find the *Dominical* or *Sundays Letter* for ever; and having the *Dominical Letter* you may in the Circle of Letters on the *Horizon* find it near the day of that Month, and count that for *Sunday*, the next under it for *Monday*, the next under that for *Tuesday*, and so in order, till you come to the Day of the Month.

#### Example.

I would know what Day of the Week June 1. Ann. 1658. Old Style, falls on; I find by the Table aforesaid the *Dominical Letter*

M 2

Letter

Letter is C, then I look in the *Calender of Old Stile* for *June 1.* and against it I find Letter E, which because it is the second Letter in order from C, therefore it is the second Day in order from *Sunday*, which is *Tuesday*.

## P R O B. XLIII.

*The Azimuth of any Star given, to find its Hour in any given Latitude.*

**T**HE *Hour of a Star* is the number of Hours that a *Star* is distant from the *Meridian*. To find which, Rectifie the *Globe* and *Quadrant of Altitude*, and bring the *Star* proposed to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. Then place the lower end of the *Quadrant of Altitude* to the given *Azimuth* in the *Horizon*, and turn the *Globe* till the *Star* come to the graduated edge of the *Quadrant of Altitude*; so shall the *Index* of the *Hour-Circle* point at the *Hour of the Star*. Only this caution you must take; If the *Star* were turned from the *Meridian* towards the *Eastern* side of the *Horizon*, you must Subtract the number of Hours the *Index* points at from 12 and the Remainder shall be the *Hour of the Star*. But if the *Star* were turned from the *Meridian* towards the *West* side of the *Horizon*, the *Hour-Index* points at, is (without more ado) the *Hour of the Star*.

## PROB. XLIV.

*How you may learn to know all the Stars in Heaven, by the Celestial Globe.*

**R**ECTIFIE the *Globe*, *Quadrant*, *Hour-Index*, and *Horizon*, as by Prob. 2. Then turn about the *Globe*, till the *Index* of the *Hour-Circle* point at the *Hour of the Night* on the *Hour-circle*. Then if every *Star* on the *Globe* had a Hole in the midst, and your Eye were placed in the Center of the *Globe*; you might by keeping your Eye in the Center, and looking through the Hole of any *Star* on the *Globe* see its *Match* in *Heaven*: that is, the same *Star* in *Heaven* which that *Star* on the *Globe* represents: For from the Center of the *Globe* there proceeds a straight  
Line

Line through the *Star* on the *Globe*, even to the same *Star* in *Heaven*. Therefore those *Stars* that are in the *Zenith* in *Heaven*, will then be on the *Zenith* on the *Globe*; those that are in the *East* in *Heaven*, will be in the *East* on the *Globe*; those in the *West* in *Heaven*, in the *West* on the *Globe*; and those *Stars* that are in any *Altitude* in *Heaven*, will at the same Time have the same *Altitude* on the *Globe*; So that if you see any *Star* in *Heaven* whose name you desire to know, you need but Observe its *Azimuth* and *Altitude*, and in the same *Azimuth* and *Altitude* on the *Globe*, you may find the same *Star*: and if it be an *Eminent Star*, you will find its Name adjoynd to it.

## Example.

December 10. at Half an Hour past 9 a Clock at Night, here at London, I see two Bright *Stars* at a pretty Distance one from another in the *South*; I desire to know the Names of them: Therefore having the *Globe* Rectified to the *Latitude* of London, and the *Quadrant of Altitude* screwed to the *Zenith*, the *Hour-Index* also Rectified, and the *Horizon* posited *Horizontally*, as by Prob. 2. I Observe the *Altitude* of those *Stars* in *Heaven* (either with a *Quadrant*, *Astrolabe*, *Cross-staff*, or the *Globe* it self, as hath been shewed Prob. 13, 16.) to be, the one 78 Degrees, the other 42 Degrees above the *Horizon*. Therefore having their *Altitudes*, I count the same Number of Degrees as for the First 78 upon the *Quadrant of Altitude* upwards, and turn it into the *South*, under the *Meridian* and see what *Star* is under 78 Degrees, for that is the same *Star* on the *Globe* which I saw in *Heaven*. Now at the first Examination of the *Globe* you may see that that *Star* is placed in the Eye of that *Asterisme* which is called *Caput Medusæ*, and indeed, that being the only *Star* of Note in that *Constellation*, bears the Name of the whole *Constellation*. The other *Stars* about it you may easily know by their Situation: As seeing two Little *Stars* to the *Westwards* of that *Star* in *Heaven*, you may see on the *Globe* that the Hithermost is in the other Eye of *Caput Medusæ*, and the Furthermost is in the *Hair* or *Snakes* of the same *Asterisme*. Looking a little to the *Southwards* of those *Stars* in *Heaven*, you may see two other Small *Stars* a little below those in the *Eyes*; Therefore to know those also, you may look on the *Globe*, and see that there is one on the  
Nose

Nose, and another *Star* in the *Cheek* of *Caput Medusæ*.

In like manner for the Second *Star* in the *Meridian*, which is 42 Degrees above the *Horizon*: If you move the *Quadrant of Altitude* (as before) to the *South* or *Meridian*, and count 42 Degrees upon the *Quadrant of Altitude*, you will find a *Star* of the Second *Magnitude* in the *Mouth* of the *Whale*: Therefore you may say that *Star* in *Heaven* is in the *Mouth* of the *Whale*: and because close to it on the *Globe* is written *Menkar*; Therefore you may know the Name of that *Star* in *Heaven* is *Menkar*.

In the *South East* and by *South* 56 Degrees above the *Horizon*, I see a very Bright *Star* in *Heaven*; therefore I bring the *Quadrant of Altitude* to the *South East* and by *South* point in the *Horizon*, and find under 56 Degrees of the *Quadrant of Altitude* a Great *Star*, to which is set the Name *Oculus Tauri*; Therefore I say the Name of that Bright *Star* in *Heaven* is *Oculus Tauri*.

In the *South East* in *Heaven* you may see three Bright *Stars* lye directly in a straight Line from one another, the Middlemost whereof is 25 Degrees or thereabouts above the *Horizon*, therefore bring the *Quadrant of Altitude* to the *South East* point of the *Horizon*, and about 25 Degrees above the *Horizon* you will see the same Great *Stars* on the *Globe*, in the *Girdle* of *Orion*: Therefore those *Stars* are called *Orions Girdle*.

At the same Time *South East* and by *East* you have about 10 Degrees above the *Horizon* the Brightest *Star* in *Heaven*, called *Sirius*, in the *Mouth* of the *Great Dog*; *Canicula* a Bright *Star* in the *Little Dog*, *East* and by *South*; about 25 Degrees above the *Horizon*: *Cor Leonis* just Rising *East North East*: you have also at the same Time on the *East* side the *Horizon*, the *Twins*, *Auriga*, the *Great Bear*; and divers other *Stars*, Eminent both for their Splendor and Magnitude.

In the *West* side the *Horizon* you have *South West* and by *West* about 4 Degrees above the *Horizon*, a Bright *Star* in the *Right Leg* of *Aquarius*: and all along to the *Southwards* in *Cetus* the *Whale*, you have other Eminent Bright *Stars*: More upwards towards the *Zenith* you have a Bright *Star* in the *Line* of the two *Fishes*: Higher yet, you have the First *Star* in  $\gamma$ , an Eminent *Star*, Because the first in all *Catalogues* that we have cognizance of; and therefore probably in the *Equinoctial Colure* when the *Stars* were first reduced into *Constellations*: yet more  
near

near the *Zenith* you have a Bright *Star* in the *Left Leg* of *Andromeda*: From thence towards the *North*, you find other very Eminent Bright *Stars* in *Cassiopea*, *Cepheus*, *Ursa minor*, in the *Tail* whereof is the *Pole Star*; and *Draco*, *Hercules*, where you turn back to *Lyra*, *Cygnus*, *Pegasus*, the *Dolphin*, &c. all which, or any other, you may easily know by their *Altitude* above the *Horizon*, and the Point of the *Compass* they Bear upon.

Thus knowing some of the most Eminent Fixed *Stars*, you may by the Figure of the Rest come to the knowledge of them also. For Example; Looking towards the *North North East* in *Heaven*, you may see Seven Bright *Stars* constituted as in this Figure. Therefore looking towards the same Quarter  $\star$  on the *Globe*, you may (without taking their *Altitude*) see the same *Stars* lying in the same Figure in the *Hinder* parts of the *Great Bear*; from whence you may conclude that those *Stars* in *Heaven* are situate in the *Hinder* parts of the *Great Bear*. These  $\star \star \star \star \star$  7 *Stars* are by us called *Charles his Wain*.

Yet nevertheless you may see some *Stars* of Note in *Heaven*, which you shall not find on the *Globe*, and those in or near about the *Ecliptick*: They are called *Planets*, and cannot be placed on the *Globe*, unless it be for a particular Time, with Black lead, or some such thing, that may be rubbed out again: Because they having a continual Motion, always alter their Places. Of those there are five in number, besides the *Sun* and *Moon*, which are also *Planets*, though they shew not like *Stars*. These five are called *Saturn*, *Jupiter*, *Mars*, *Venus*, *Mercury*; yet *Mercury* is very rarely seen: Because he never Rising above an Hour before the *Sun*, or Setting above an Hour after, for the most part hath his Light so overspread with the dazelling Beams of the Glittering *Sun*, that sometimes when he is seen, he seems rather to be a More in the *Sun's* Beams, than a Body endowed with so much Brightness as *Stars* and *Planets* seem to be.

Now there are divers Ways (by some of which) you may at all Times know those *Planets* from the Fixed *Stars*: as first, Their not *Twinkling*, for therein they differ from Fixed *Stars*, because they most commonly do *Twinkle*, but *Planets* never; unless it be *Mars*; and yet he *Twinkles* but very seldom neither.

Secondly, They appear of a considerable *Magnitude*, as  $\star$  some

sometimes Appears Greater by far than a *Star* of the First *Magnitude*; and 2 many Times Bigger than He. They are both Glittering *Stars*, of a Bright *Silver* colour, but 2 most Radiant, especially when she is in Her *Perigeon*. 3 appears like a *Star* of the Second *Magnitude*; and is of a *Copperish* colour; 4 shews like a *Star* of the Third *Magnitude*; and is of a *Lead-n* colour; and he (of all others) is most difficult to be known from a Fixed *Star*, partly because of his Minority, and partly because of the slowness of his Motion. 5 is very seldom seen (as aforesaid) unless it be in a Morning when he Rises before the *Sun*, or in an Evening when he Sets after the *Sun*: He is of a pale whitish colour, like *Quicksilver*, and appears like a *Star* of the Third *Magnitude*: He may be known by the Company he keeps, for he is never above 19 Degrees Distant from the *Sun*.

Thirdly, the *Planets* may be known from the Fixed *Stars* by their *Azimuths* and *Altitudes* Observed (as hath been taught before) for if when you have Taken the *Azimuth* and *Altitude* of the *Star* in *Heaven* you doubt to be a *Planet*, and you find not on the *Globe* in the same *Azimuth* and *Altitude* a *Star* appearing to be of the same *Magnitude* that that in *Heaven* appears to be, you may conclude that that in *Heaven* is a *Planet*. Yet notwithstanding it may happen that a *Planet* may be in the same Degree of *Longitude* and *Latitude* in the *Zodiack* that some Eminent Fixed *Star* is in, as in the Degree and Minute of *Longitude* and *Latitude* that *Cor Leonis*, or the *Bulls Eye*, or *Scorpions Heart* is in, and so may Eclipse that *Star*, by being placed between us and it; But that happens very seldom & rarely; but if you doubt it, you may apply your self to some other of the precedent and subsequent Rules here set down for knowing *Planets* from fixed *Stars*.

The Fourth way is by Shifting their Places; for the *Planets* having a continual Motion, do continually Alter their Places, as 3 Moves about Half a Degree in a Day; 2 about a Whole Degree; but 4 and 5 Move very slowly; 4 not Moving above 5 Minutes, and 5 seldom above 2 Minutes. Yet by their Motions alone the *Planets* may be known to be *Planets*, if you will precisely Observe their Distance from any known Fixed *Star* in or near the *Ecliptick*: as, On this Night and the next Night after, observe whether they retain the same Distance they had the Night before; which if they do, then are they Fixed *Stars*; but if they do not, then are they *Planets*: yet this Caution is to be given you in this Rule also, that

That the *Planets* sometime, are said to be *Stationary*, as not altering a Minute in Place Forwards or Backwards in 6 or 7 Daies together. Therefore, if you find cause to doubt whether your *Star* be a *Planet*, or a Fixed *Star*, you may for the Help of your Understanding confer with some of the former Rules, unless you are willing to wait 8 or 9 days longer, and so by Observation of its Motion resolve your self. Or.

Fifthly, you may apply your self to an *Ephemeris* for that year, and see if on that Day you find any *Planet* in the Degree and Minute of the *Zodiack* you see that *Star* you question in *Heaven*, and if there be no *Planet* in that Degree of the *Zodiack*, you may conclude it is no *Planet*, but a Fixed *Star*.

### PROB. XLV.

*How to hang the Terrestrial Globe in such a Position, that by the Suns Shining upon it you may (with great delight) at once behold the Demonstration of many Principles in Astronomy and Geography.*

TAke the *Terrestrial Ball* out of the *Horizon*, and fasten a Thred on the *Brazen Meridian* to the Degree of the *Latitude* of your Place; by this Thred Hang the *Globe* in a place where the *Suns* Beams may have a free Access to it; Then direct the *Poles* of the *Globe* to their proper *Poles* in *Heaven*, the *North Pole* to the *North*, and the *South Pole* to the *South*; and with a Thred fastned to either *Pole*, brace the *Globe* so, that it do not turn from its Position: Then bring your Habitation to the *Meridian*, so shall your *Terrestrial Globe* be Rectified to correspond in all Respects with the *Earth* it self; even as in Prob. 44. the *Celestial Globe* doth; the *Poles* of the *Globe* to the *Poles* of the *World*, the *Meridian* of the *Globe* to the *Meridian* of the *World*; and the several Regions on the *Globe* made correspondent to the same Regions on the *Earth*: So that with great delight you may behold,

1. How the counterfeit *Earth* (like the true one) will have one *Hemisphere* Sun-shine Light, and the other Shadowed, and as it were Dark. By the Lightned *Hemisphere* you may see that it is Day in all Places that are Situate under it; for on them the *Sun* doth Shine; and that it is Night at the same Time in those Places that

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that

that are Situate in the Shadowed *Hemisphere*; for on them the *Sun* doth not Shine; and therefore they remain in Darknes.

2. If in the middle of the Enlightned *Hemisphere* you set a *Spherick Gnomon* Perpendicularly, it will project no Shadow, but shews that the *Sun* is just in the *Zenith* of that Place; that is directly over the Heads of the Inhabitants of that Place: and the point that the *Spherick Gnomon* stands on, being removed to the *Meridian* shews the *Declination* of the *Sun* on the *Meridian* for that Day.

3. If you draw a *Meridian* Line from one *Pole* to the other; in all places under that Line, it is Noon: in those Places Situate to the *West* it is Morning, for with them the *Sun* is *East*: And in those Places Situate to the *East* it is Evening; for with them the *Sun* is *West*.

4. Note the Degree of the *Equator* where the Enlightned *Hemisphere* is parted from the Shadowed; for the Number of Degrees of the *Equator* intercepted between that Degree and the *Meridian* of any Place converted into Hours (by accounting for every 15 Degrees 1 Hour) shews, if the *Sun* be *Eastwards* of that Place, how long it will be ere the *Sun* Rises, Sets, or comes to the *Meridian* of that Place, or if the *Sun* be *Westward* of that Place, how long it is since the *Sun* Rose or Set, or was at the *Meridian* of that Place.

5. The Inhabitants of all Places between the Enlightned and Shadowed *Hemisphere*, behold the *Sun* in the *Horizon*: Those *Westwards* of the *Meridian* Semi-circle drawn through the middle of the Enlightned *Hemisphere* behold the *Sun* Rising: Those is the *East*, see it Setting.

6. So many Degrees as the *Sun* reaches beyond either the *North* or *South Pole*, so many Degrees is the *Declination* of the *Sun*, either *Northwards* or *Southwards*: and in all those Places comprehended in a Circle described at the Termination of the *Sun-shine*, about that *Pole*, it is always Day, till the *Sun* Decrease in *Declination*: for the *Sun* goes not Below their *Horizon*, as you may see by turning the *Globe* about upon its *Axis*, and in the opposite *Pole*, at the same Distance, the *Sun-shine* not reaching thither, it will be always Night, till the *Sun* Decrease in *Declination*: because the *Sun* Rises not above their *Horizon*.

7. If you let the *Globe* Hang steady, you may see on the *East* side of the *Globe*, in what Places it grows Night; and on the *West*

*West* side the *Globe*, how by little and little the *Sun* encroaches upon it; and therefore makes it Day.

8. If you make of Paper or Parchment a narrow Girdle, to begirt the *Globe* just in the *Equinoctial*, and divide it into 24 equal parts, to represent the 24 Hours of Day and Night, and mark it in order with I, II, III, &c. to XII and then begin again with I, II, III, &c. to the other XII. you may by placing one of the XII. upon the *Equinoctial* under the *Meridian* of your place, have a continual *Sun-dial* of it, and the Hour of the Day given on it at once in two Places, one by the parting the Enlightned *Hemisphere* from the Shadowed on the *Eastern* side, the other by parting the Enlightned *Hemisphere* from the Shadowed on the *Western* side the *Globe*. Much more might be said on this Probleme: But the Ingenious Artift may of Himself find out diversities of Speculations: therefore I forbear.

#### PROB. XLVI.

*To know by the Terrestrial Globe in the Zenith of what Place of the Earth the Sun is.*

THIS may be performed by the former Probleme in the Day Time, if the *Sun* Shines; but not else. But to find it at all Times, do thus: Bring the Place for your Habitation to the *Meridian*, and the *Index* of the *Hour-circle* to 12; Then turn the *Globe Eastwards*, if After Noon, or *Westwards*, if Before Noon, till the *Index* of the *Hour-circle* pass by so many Hours from 12 as your Time given is, either Before or After Noon: so shall the *Sun* be in the *Zenith* of that Place where the *Meridian* intersects the *Parallel* of the *Sun's Declination* for that Day.

#### Example.

May 10. at Three Quarters of an Hour past 4 a Clock Afternoon, I would know in what Place of the *Earth* the *Sun* is in the *Zenith*. My Habitation is *London*. Therefore I bring *London* to the *Meridian*, and the *Index* of the *Hour-circle* to 12. and because it is After-noon, I turn the *Globe Eastwards*, till the *Index* passeth through 4 Hours and 3 Quarters, or (which is all one) till 70 Degrees 15 Minutes of the *Equator* pass through

the *Meridian*. Then I find by Prob. 5. the *Sun's Declination* is 20 Degrees 5 Minutes, which I find upon the *Meridian*, and in that Place just under that Degree and Minute on the *Globe*, the *Sun* is in the *Zenith*: which in this Example is in the *North-East Cape of Hispaniola*.

Having thus found in what Place of the *Earth* the *Sun* is in the *Zenith*: Bring that Place to the *Meridian*, and Elevate its respective *Pole* according to its respective *Elevation*; so shall all Places cut by the *Horizon* have the *Sun* in their *Horizon*: Those to the *Eastwards* shall have the *Sun* Setting; those to the *Westwards* shall have it Rising in their *Horizon*: those at the intersection of the *Meridian* and *Horizon* under the Elevated *Pole*, have the *Sun* in their *Horizon* at Lowest, but Rising; those at the intersection of the *Meridian* and *Horizon* under the Depressed *Pole*, have the *Sun* in their *Horizon* at Highest, but Setting. Thus in those Countries that are above the *Horizon* it is Day Light, and in those but 18 Degrees below the *Horizon* it is *Twilight*: But in those Countries further below the *Horizon* it is at that Time Dark Night: And those Countries within the *Parallel* of the same number of Degrees from the Elevated *Pole* that the *Sun's Declination* is from the *Equinoctial*, have the *Sun* always Above the *Horizon*, till the *Sun* have less respective *Declination* than the Elevated *Pole*; and those within the same *Parallel* of the Depressed *Pole* have the *Sun* always Below their *Horizon*, till the *Sun* inclines more towards the Depressed *Pole*; As you may see by turning about the *Globe*; for in this position, that portion of the *Globe* intercepted between the Elevated *Pole* and the *Parallel* Circle of 20 Degrees 5 Minutes from the *Pole*, doth not Descend below the *Horizon*: neither doth that portion of the *Globe* intercepted between the Depressed *Pole* and the *Parallel* Circle within 20 Degrees 5 Minutes of that *Pole* Ascend above the *Horizon*.

#### PROB. XLVII.

*To find in what different Places of the Earth the Sun hath the same Altitude at the same Time.*

Find by the former Probleme in what Place of the *Earth* the *Sun* is in the *Zenith*, and bring that Place on the *Globe*

*Globe* to the *Zenith*, and on the *Meridian* (there) screw the *Quadrant of Altitude*, and turn it about the *Horizon*, describing Degrees of *Almicantars* thereby, as by Prob. 23. and all those Countries in any *Almicantar* on the *Globe*, shall have the *Sun* Elevated the same number of Degrees above their *Horizon*. Thus those Countries in the tenth *Almicantar* shall have the *Sun* Elevated 10 Degrees Above their *Horizon*; those in the 20th *Almicantar* shall have the *Sun* Elevated 20 Degrees Above their *Horizon*; those in the 30th, 30 Degrees, &c. So that you may see, when the *Sun* is in the *Zenith* of any Place, All the Countries or Cities in one and the same *Almicantar* have the *Sun* in one Height at the same Time Above their *Horizon*. But to find in what Different Places the *Sun* hath the same Height at the same Time, as well Before or After Noon, as at Full Noon; and that in Countries that have Greater *Latitude* than the *Sun's* greatest *Declination* (and therefore cannot have the *Sun* in their *Zenith*) requires another Operation.

Therefore, Elevate its respective *Pole* according to your respective *Latitude*; and let the Degree of the *Brazen Meridian* which is in the *Zenith* represent your Habitation, and the Degree of the *Ecliptick* the *Sun* is in represent the *Sun*: Then bring the *Sun* to the *Meridian*, and the *Index* of the *Hour-Circle* to 12, and turn the *Globe* *Eastwards*, if Before Noon, or *Westwards*, if After Noon, till the *Index* point to the Hour of the Day; Then place the lower end of the *Quadrant of Altitude* to the East point of the *Horizon*, and move the upper end (by sliding the Nut over the *Meridian*) till the edge of the *Quadrant* touch the place of the *Sun*: Then see at what Degree of the *Meridian* the upper end of the *Quadrant of Altitude* touches the *Meridian*, and Subtract that Number of Degrees from the *Latitude* of your Place, and count the Number of Remaining Degrees on the *Meridian*, on the contrary side the Degree of the *Meridian*, where the upper end of the *Quadrant of Altitude* touches the *Meridian*, and where that Number of Degrees ends, on the *Meridian*, in that *Latitude* and your Habitations *Longitude*, hath the *Sun* the same Height at the same Time.

#### Example,

May 10. at 53 Minutes past 8 a Clock in the Morning, I would



would know in what Place the *Sun* shall have the same *Altitude* it shall have at *London*. *Londons Latitude* found by Prob. 1. is  $51\frac{1}{2}$  Degrees *Northwards*: And because the *Elevation* of the *Pole* is equal to the *Latitude* of the Place (as was shewed Prob. 15.) Therefore I Elevate the *North Pole*  $51\frac{1}{2}$  Degrees, so shall  $51\frac{1}{2}$  Degrees on the *Meridian* be in the *Zenith*: This  $51\frac{1}{2}$  Degrees on the *Meridian* represents *London*. The *Suns* place found by Prob. 3. is  $8\ 29$ . Therefore I bring  $8\ 29$  to the *Meridian*, and the *Hour-Index* to 12 on the *Hour-circle*: Then I turn the *Globe Eastwards* (because it is Before Noon) till the *Index* point at 8 Hours  $53$  Minutes in the *Hour-circle*, and place the lower end of the *Quadrant of Altitude* to the *East* point in the *Horizon*, and slide the upper end either *North* or *Southwards* on the *Meridian* till the graduated edge cut the Degree of the *Ecliptick* the *Sun* is in: Then I examine on the *Meridian* what Degree the upper end of the *Quadrant of Altitude* touches; which in this example I find is 28 Degrees; Therefore I subtract 28 from  $51\frac{1}{2}$  *Londons Latitude*, and there remains  $23\frac{1}{2}$ . Then counting on the *Meridian*  $23\frac{1}{2}$  Degrees backwards, from the point where the *Quadrant of Altitude* touched the *Meridian*, I come to 4 Degrees on the *Meridian*, *Northwards*. Therefore I say, In the *North Latitude* of 4 Degrees, and in the *Longitude* of *London* (which is about *C. Apollonia* on the Coast of *Guinea*) the *Sun* May 10. at  $53$  Min. past 8 a Clock in the Morning hath the same *Altitude* above the *Horizon* it hath here at *London*.

The *Quadrant of Altitude* thus applied to the *East* point of the *Horizon* makes Right Angles with all points on the *Meridian*, even as all the *Meridians* proceeding from the *Pole* do with the *Equator*: Because the *East* point of the *Horizon* is here made the Center or *Pole* of the Plain of the *Meridian*: therefore the *Quadrant* being applyed both to the *East* point and the *Suns* place, projects a Line to intersect the *Meridian* in the Middle point between the *Latitude* of your Habitation and the *Latitude* of that Place in which the *Sun* shall have the same *Altitude* it hath at your Habitation at the same Time. Thus it falls out that those that inhabit 5 Deg. to the *Northwards* of this intersection, have the *Sun* the same Height that they have that inhabit 5 Deg. to the *Southwards* of it: and those 10, 20, 30 Deg. more or less, to the *Northwards*, have the *Sun* in the same Height that they have that are 10, 20, 30. Deg. more or less,

to

to the *Southwards*: So that this Prob. may be done yet easier with your *Compasses*, thus; The *Globe* and *Hour-Index* Rectified: Turn about the *Globe* till the *Hour-Index* point to the Hour of the Day: Then pitch one Foot of your *Compasses* in the *Suns* Place, and extend the other to the Degree of *Latitude* on the *Meridian*, which in this Example is  $51\frac{1}{2}$  Degrees *North*; then keeping the first Foot of your *Compasses* on the Degree of the *Sun*, turn about the other Foot to the *Meridian*, and it will fall upon 4, as before.

By this Probleme you may take notice how grossly they err that think they can find the Height of the *Pole* at any Hour of the Day, by the *Suns* Height: Because they do not consider that it is impossible to find the Hour of the Day, unless they first know the Height of the *Pole*.

### PROB. XLVIII.

To find the Length of the Longest and Shortest Artificial Day or Night.

THE Artificial Day is that space of Time which the *Sun* is above the *Horizon* of any Place: and the Artificial Night is that space of Time which the *Sun* is under the *Horizon* of any Place. They are Measured in the *Hour-circle*, by Hours and Minutes.

There is a constant and unequal disproportion in the Length of these Days and Nights; which is caused both by the Alteration of the *Suns Declination*, and the difference of the *Poles Elevation*.

Those that Inhabit on the *North* side the *Equator* have their Longest Day when the *Sun* enters *Cancer*; and those that Inhabit on the *South* side the *Equator*, have their Longest Day when the *Sun* enters *Capricorn*. But to know how Long the Longest Day is in any *North* or *South* Elevation, Raise the *North* or *South Pole* according to the Elevation of the Place, and bring *Cancer* for *North* Elevation, or *Capricorn* for *South* Elevation to the *Meridian*, and the *Index* of the *Hour-circle* to 12. Then turn the *Globe* about till *Cancer* for *North*, or *Capricorn* for *South* Elevation come to the *West* side the *Horizon*, and the number of Hours and Minutes pointed at on the *Hour-circle* doubled, is the number of Hours and Minutes of the Longest Day.

The Length of the Night to that Day is found by Subtracting the Length of the Day from 24, for the Remainder is

is the length of the Night.

The Shortest Day in that *Latitude* is the Length of the Shortest Night, found as before. And the Longest Night is of the same Length with the Longest Day.

### Example.

I would know the Length of the Longest Day at *London*. Therefore I Elevate the *North Pole*  $51\frac{1}{2}$  Degrees, and bring  $\S$  to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. Then I turn  $\S$  to the *Western* side the *Horizon*, and find the *Index* point at 8 Hours 18 Minutes, which being Doubled, makes 16 Hours 36 Minutes, for the Length of the Longest Day here at *London*.

### PROB. XLIX.

*To find how much the Pole is Raised or Depressed, where the Longest Day is an Hour Longer, or Shorter than it is in your Habitation.*

Rectifie the *Globe* to the *Latitude* of your Place; and make a Prick at that point of the *Tropic* which is at the *Meridian*; I mean at the *Tropic* of *Cancer*, if your Habitation be on the *North* side the *Equator*; or  $\forall$  if your Habitation be on the *South* side the *Equator*: And if you would know where the Longest Day is just an Hour Longer than it is at your Habitation, turn the *Globe* to the *Westward* till  $7\frac{1}{2}$  Degrees of the *Equator* pass through the *Meridian*, and make there another Prick on the *Tropic*: then turn about the *Globe* till the First Prick come to the *Horizon*; and move the *Meridian* through the Notches of the *Horizon* till the Second Prick on the *Tropic* come to the *Horizon*; so shall the Arch of the *Meridian* contained between the Elevation of your Place, and the Degree of the *Meridian* at the *Horizon*, be the number of Degrees that the *Pole* is Elevated Higher than it is in your *Latitude*.

to

### Example.

I would know in what *Latitude* the Longest Day is an Hour Longer than it is at *London*. Therefore I Rectifie the *Globe* to  $51\frac{1}{2}$  Deg. and where the *Meridian* cuts the *Tropic* of  $\S$  I make a Prick

a. Prick; then I note what Degree of the *Equator* is at the *Meridian*, and from that Degree on the *Equator* count  $7\frac{1}{2}$  Degrees to the *Eastwards*, and bring those  $7\frac{1}{2}$  Degrees to the *Meridian* also, and again, where the *Meridian* cuts the *Tropic* of  $\S$  I make another Prick, so shall  $7\frac{1}{2}$  Degrees of the *Tropic* be contained between those two Pricks: Then I turn the *Globe* about till the First Prick come to the *Horizon*, and (with a Quill thrust between the *Meridian* and the Ball) I fasten the *Globe* in this position: Afterwards I move the *Meridian* through the Notches of the *Horizon*, till the Second Prick Rises up to the *Horizon*, and then I find  $56\frac{1}{2}$  Degrees of the *Meridian* cut by the Superficies of the *Horizon*: Therefore I say, in the *Latitude* of  $56\frac{1}{2}$  Degrees the Longest Day is an Hour Longer than it is here at *London*.

But if you would know in what *Latitude* the Days are an Hour Shorter, you must make your Second Prick  $7\frac{1}{2}$  Degrees to the *Westwards* of the First, and after you have brought the First Prick to the *Horizon*, you must Depress the *Pole* till the Second Prick Descends to the *Horizon*: so shall the Degree of the *Meridian* at the *Horizon* shew in what Elevation of the *Pole* the Days shall be an Hour Shorter.

By this Probleme may be found the Alteration of *Climates*: for (as was said in the Definition of *Climates*, Book 1. fol. 28.) *Climates* Alter according to the Half-Hourly increasing of the Longest Day: therefore the *Latitude* of  $56\frac{1}{2}$  Degrees (having its Days increased an whole Hour) is distant from the *Latitude* of *London* by the space of two *Climates*.

### PROB. L.

*The Suns Place given, to find what Alteration of Declination it must have to make the Day an Hour Longer or Shorter: And in what number of Days it will be.*

Rectifie the *Globe* to the *Latitude* of the Place, and bring the *Suns* place to the *East* side the *Horizon*, and note against what Degree of the *Horizon* it is: then bring one of the *Colures* to intersect the *Horizon* in that Deg. of the *Horizon*, and at the point of intersection make a Prick in the *Colure*; and Observe what Deg. of the *Equator* is then at the *Meridian*: Then turn the *Globe Westwards*, if the Days Shorten, but *Eastwards* if they

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they

they Lengthen till  $7\frac{1}{2}$  Degrees of the *Equator* pass through the *Meridian*, and where the *Horizon* intersects the same *Colure*, make another Prick in the *Colure*: afterwards bring the *Colure* to the *Meridian*, and count the number of Degrees between the two Pricks, for so many Degrees must the *Sun's Declination* Alter to Lengthen or Shorten the day and Hour.

*Example.*

The *Sun's* place is 10. I would know how much he must alter his *Declination* before the Day is an Hour Longer here at *London*. Therefore I Rectifie the *Globe* to the *Latitude* of *London*. and bring 10. to the *East* side the *Horizon*, and find it against  $24\frac{1}{2}$  Degrees from the *East* point: Therefore I bring one of the *Colures* to this  $24\frac{1}{2}$  Degrees, and close by the edge of the *Horizon* I make a Prick with black lead, in the *Colure*: then keeping the *Globe* in this position, I look what Deg. of the *Equator* is then at the *Meridian*, and find 250.15. and because the Days Lengthen, I turn the *Globe Eastwards* till  $7\frac{1}{2}$  Degrees from the aforesaid 250.15. pass through the *Meridian*: then keeping the *Globe* in this position, I make another Prick in the *Colure*, and bringing this *Colure* to the *Meridian*, I find a little more than 5 Deg. of the *Meridian* contained between the two Pricks: therefore I say, when the *Sun* is in 8 10 Degrees, he must alter his *Declination* a little more than 5 Degrees to make the Day an Hour Longer.

Now to know in what number of Days he shall alter this *Declination*, you must find the *Declination* of the two Pricks on the *Colure*, as you found the *Sun's Declination* by Prob. 5. and the Arch of the *Ecliptick* that passes through the *Meridian* while the *Globe* is turned from the First Pricks *Declination* to the Second Pricks *Declination*, is the number of the *Ecliptical* Degrees that the *Sun* is to pass while he alters this *Declination*; and the Deg. of the *Ecliptick* then at the *Meridian* is (with respect had to the Quarter of the Year) the Place the *Sun* shall have when its *Declination* shall be altered so much as to make the Day an Hour Longer.

Thus having the *Sun's* first Place given, and its Second Place found; you may by finding those two Places on the Plain of the *Horizon*, also find the number of Days comprehended between them, as you are taught by the fourth Probleme.

This

This Probleme thus wrought for different Times of the Year, will shew the fallacy of that Vulgar Rule which makes the Day to be Lengthned or Shortned an Hour in every Fifteen Days: when as the Lengthning or Shortning of Days keep no such equality of Proportion: for when the *Sun* is near the *Equinoctial* points the Days Lengthen or Shorten very Fast: but when he is near the *Tropical* points, very slowly.

PROB. LI.

*Of the difference of Civil and Natural Days, commonly called the Equation of Civil Days. And how it may be found by the Globe.*

THE *Civil Day* is that space of Time containing just 24 Hours, reckoned from 12 a Clock on one Day to 12 a Clock the next Day; in which space of Time the *Equinoctial* makes upon the *Poles* of the *World* a Diurnal Revolution. The *Natural Day* is that space of Time wherein the *Sun* moveth from the *Meridian* of any Place to the same *Meridian* again. These Days are at one Time of the Year Longer than at another; and at all times Longer than the *Civil Days*. There is but small discrepancy between them, yet some there is, made by a two-fold Cause. For First, The *Sun's* Apparent Motion is different from his true Motion; He being much slower in his *Apogeeum* than he is in his *Perigeeum*. For when the *Sun* is in his *Apogeeum* he scarce Moves 58 Minutes from *West* to *East* in a *Civil Day*, but when he is in his *Perigeeum* he Moves above 61 Minutes in a *Civil Day*: and therefore increases his *Right Ascension* more in equal Time.

The Second Cause is the difference of *Right Ascension* answerable to equal parts of the *Ecliptick*: for about ♄ and ♃ the differences of *Right Ascensions* are far greater than about ♋ and ♌: for about ♋ and ♌ the *Right Ascension* of 10 Deg. is but but 9 Degrees 11 Minutes; but about ♄ and ♃ the *Right Ascension* of 10 Degrees will be found to be 10 Degrees 53 Minutes; as by the *Globe* will appear.

But because of the finalness of the *Globes* Graduation, you cannot actually distinguish to parts near enough for the Solution of this Probleme, if you would enquire the Difference in Length of two single Days; Therefore it will be requisite to take some

ber of Days together; suppose 20. Therefore find by Prob. 3. the Places of the *Sun* for the beginning and ending of those Days you would compare; and find the *Right Ascension* answerable to each Place in the *Ecliptick*; and also the Differences of *Right Ascensions* answerable to the *Sun's* Motion in each number of Days: Then compare the Differences of *Right Ascensions* together; and by Subtracting the Lesser from the Greater, you will have the number of Degrees and Minutes of the *Equator* that have passed through the *Meridian* more in one number of Days than in the other number of Days: which Degrees of the *Equator* converted into *Time*, is the number of Minutes that the one number of Days is Longer than the other number of Days.

### Example.

I would know what difference of *Time* there is in the Length of the first 20 Days of *December*, and the first 20 Days of *March*. I find by Prob. 3. the *Sun's* Place *December* 1. is  $\uparrow$  19. 45. at the end of 20 Days, viz. on the 21 Day his Place is  $\uparrow$  10. 11. The *Sun's* Place *March* 1. is  $\times$  21. 16, at the 20 Days end, viz. *March* 21. his Place is  $\vee$  11. 3.

I find by Prob. 26. the *Right Ascension* answerable to

$\left. \begin{array}{l} \uparrow 19. 45 \\ \uparrow 10. 11 \\ \times 21. 16 \\ \vee 11. 3 \end{array} \right\}$	is	$\left\{ \begin{array}{l} 258. 10. \\ 280. 25. \\ 352. 00. \\ 9. 40. \end{array} \right.$
--	----	---

and the Difference of *Right Ascensions* contained between the first Day in each Month, and the 21 of the same Month, by Subtracting the Lesser from the Greater is, for

$\left\{ \begin{array}{l} 258. 10. \\ 280. 25. \\ 22. 15. \end{array} \right.$	And for	$\left\{ \begin{array}{l} 352. 00. \\ 9. 40. \\ 17. 40. \end{array} \right.$
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But note, because the *Vernal Colure* (where the Degrees of *Right Ascension* begin and end their account) is intercepted in the Arch of the *Sun's* Motion from the first to the 21 of *March*. therefore instead of Subtracting the Lesser number of Degrees of *Right Ascension* from the Greater, viz. 9. 40. from 352. I do for finding the Difference of the *Ascensional Arch* of the *Sun's* Motion in those 20 Days, Subtract the foresaid 352. Deg. from 360, and the Remains is 8. which is the Difference of *Right Ascension* from  $\times$  21. 16. to the *Equinoctial Colure*: to which 8

Adding

Adding 9 Degrees 40 Minutes, the *Right Ascension* from the *Equinoctial Colure*, to  $\vee$  11. 3. it makes 17 Degrees 40 Minutes for the Difference of *Right Ascensions* between  $\times$  21. 16. and  $\vee$  11. 3. Then I find the Difference of this Difference of *Right Ascension*, by Subtracting the Less from the Greater, viz. 17. 40. from 22. 15. and the remains is 4 Degrees 35 Minutes, for the number of Degrees and Minutes of the *Equator* that pass through the *Meridian* in the first 20 Days in the Month of *December*, more than in the first 20 Days of the Month of *March*: which 4 Degrees 35 Minutes converted into *Time*, gives 19 Minutes, that is, a Quarter of an Hour, and 4 Minutes that the first 20 Days of *December* aforesaid, are Longer than the first 20 Days of *March*.

### PROB. LII.

*How to find the Hour of the Night, when the Moon Shines on a Sun Dial by help of the Globe.*

**R**ectifie the *Globe*, and find by Prob. 54. or an *Ephemeris*, the *Moons* Place at Noon: Bring it to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. and turn about the *Globe* till the *Index* of the *Hour-Circle* points to the same Hour the Shade of the *Moon* falls on the *Sun Dial*. Then by Prob. 3. find the *Sun's* Place at Noon, and see how many Degrees of *Right Ascension* are contained between the *Sun's* Place and the Deg. of the *Equator* at the *Meridian*, when the *Index* of the *Hour-Circle* is brought to the Hour the *Moon* Shines on in the *Sun Dial*; for those number of Degrees converted into *Time*, shall be the *Time* from Noon, or the Hour of the Night. Only note, Respect must be had to the Motion of the *Moon* from *West* to *East*, for so Swift is her Mean Motion, that it is accounted to be above 12 Degrees in 24 Hours: that is 6 Degrees in 12 Hours, 3 Degrees in 6 Hours, &c. and this also converted into *Time*, as aforesaid, you must Add proportionably to the *Time* found from Noon; and the Sum shall give you the true Hour of the Night.

### Example.

Here at *London* I desire to know the Hour of the Night, *January* 6. this present Year 1658. The *Moons* Place found by an

an *Ephemeris*, or for want of an *Ephemeris*, by Prob. 54. is in  $\Pi 21$  Degrees 22 Minutes; therefore I rectified the *Globe* to *Londons Latitude*, and brought  $\Pi 21.22$  Minutes to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. then by Prob. 3. I found the *Suns Place* in  $\Pi 26$  Degrees 46 Minutes, and by Prob. 26. I found his *Right Ascension* to be 300 Degrees; Then I turned about the *Globe* till the *Index* of the *Hour-Circle* pointed at 10 Hours, and at the Degree of the *Equator* at the *Meridian* I made a Prick; hen I accounted the number of Degrees of the *Equator* contained between the foresaid 300 Deg. and this Prick, and found them  $111\frac{1}{4}$  Degrees, which converted into *Time*, by allowing 15 Degrees for an Hour, give 7 Hours, 25 Minutes *Time* from Noon: which if the *Moons Motion* were not to be considered, should be the immediate Hour of the, Night: But by the Rule aforesaid, the *Moons Motion* from *West* to *East*, in 7 Hours 25 Minutes is 3 Degrees 42 Minutes: and this 3 Degrees 42 Minutes being converted into *Time*, is 14 Minutes more, which being added to 7 Hours 25 Minutes make 7 Hours 39 Minutes, for the true Hour of the Night.

### PROB. LIII.

To find the Dominical Letter, the Prime Epact, Easter Day, and the rest of the Moveable Feasts for ever.

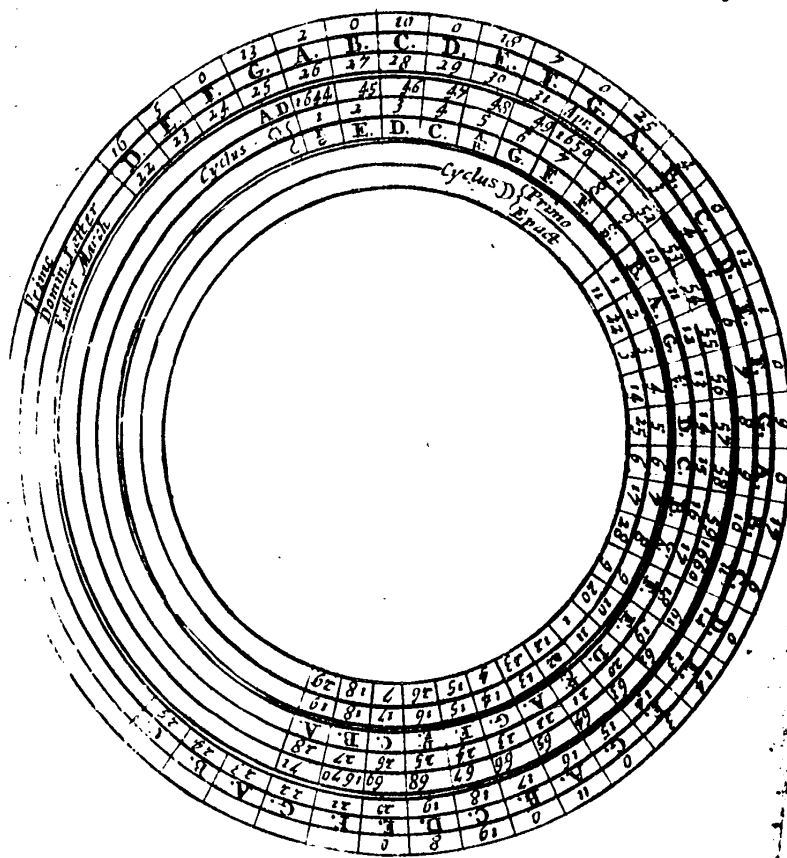
Though these Problemes cannot be performed by the *Globe*, because of the several Changes, and irregular Accounts that their Rules are framed upon; yet because they are of frequent and Vulgar Use, and for that the Solution of many other Questions will have dependency on the knowledge of these. Therefore I have thought fit here to insert this *Table* of Mr. Palmers, by which you may find them all.

I shall not insist upon the Reasons of the several Changes of Letters, and Numbers, Himself having already very learnedly handled that Subject, in his Book of the *Catholic Planisphere*, Book. I Chapter 11. (to which I refer you) Neither shall I need to give you any other Instructions for finding what is here proposed, than what himself hath given in his fourth Book, Chapter, 66 and part of 67. Therefore take it as he there delivers it.

An-

An *Example* shall serve here instead of a *Rule*. For the Year 1657. I would know all these: wherefore I seek the Year 1657. in the *Table* of the *Suns Cycle*, and over against it, find 14 for the Year of the *Cycle of the Sun*, and D for the *Dominical Letter*. And note here that every *Leap-year* hath 2 *Dominical Letters* (as 1660 hath A G) and the First (*viz.* A) serveth that Year till *February 25*, and the Second (G) for the rest of the Year. And note that these Letters go always backwards when you count forwards (as B A, then G F, &c. not F G, and then A B) as you may see by the *Table*.

Then in the *Table* of the *Cycle of the Moon*, I have for the Year 1657. the *Prime* 5. the *Epact* 25. Those had, I go to the *Table* for *Easter*, and seek there in the first rank the *Prime* 5. and



under

under it in the middle Rank stands E; that is not my *Dominical Letter*; therefore I seek not backward, but always forward in the middle Rank till I come to my *Dominical Letter* D, and under it I find in the third Rank *March. 29* upon which *Easter Day* falls this Year 1657. The rest of the *Movable Feasts* may be had by their distances from *Easter*, which are always the same. Only for *Advent Sunday*, remember that the next Sunday after *November 26* is *Advent Sunday*. Read *Book, I. 11*. and that will sufficiently instruct you with this *Example*.

### To find the Age of the Moon.

Remember first that the *Epact* begins with *March*, which must be here accounted the First Month: Then if you Add to the *Epact* the number of the Month Current, and the number of the Day of the Month Current, the sum or the Excess above 30 is the *Moons Age*.

*Example, January, 20. 1656.* According to the Accompt of the Church of *England* (who begin the Year with *March 25*, which was the *Equinoctial Day* about Christs Time) the *Epact* is 14. *January* is the 11th Month, and the 20th Day is proposed; now Add 14. 11 and 20 together, they make 45. out of which I take 30. and there Remains 15. the *Moons Age*.

### PROB. LIV.

*The Age of the Moon given to find her Place in the Ecliptick according to her Mean Motion.*

THIS Probleme may be performed exact enough for common Uses by the *Globe*, but in regard it only shews the *Moons Place* in the *Ecliptick* according to her Mean Motion, it will often fail you some few Degrees of her true Place. The work is thus,

First set Figures to every Twelfth Deg. of the *Equinoctial*, accounted from the *Equinoctial Colure*, marking them with 1, 2, 3, 4, &c. to 30. which will end where you began, viz. at the *Equinoctial Colure* again: so shall the *Equinoctial* be divided into 30 equal parts representing the 30 Days of the *Moons Age*. These Figures (to distinguish them from the Degrees of the *Equator*) were best be writ with Red Ink.

When

When you would enquire the *Moons Place*, Elevate the *North Pole* 90 Degrees, that is, in the *Zenith*, so shall the *Equator* lye in the *Horizon*: Then bring the *Equinoctial Colure* against the Day of the Month in the *Horizon*, so shall the *Moons Age* written in Red Figures, stand against the Sign and Degree in the *Horizon* that the *Moon* is in at that Time.

### Example.

*September 28. 1658.* I would know the *Moons Place* in the *Ecliptick*, She being then 12 Days Old. Therefore I Elevate the *North Pole* 90 Degrees above the *Horizon*, and turn the *Globe* about till the *Equinoctial Colure* come to *September 28*. in the Circle of Days on the *Horizon*; then looking against what Sign and Degree of the *Ecliptick Circle* in the *Horizon* the 12th division in Red Figures stands I find ♎. which is the Sign and Degree the *Moon* is in, according to her *Mean Motion*.

This Probleme may be applied to many Uses: for having the *Moons Place* you may find the Time of her *Rising*, *Setting*, and *Shining*, &c. by working with Her, as you were taught to work with the *Sun*, in several foregoing Problemes, proper to each purpose.

### PROB. LV.

*Having the Longitude and Latitude, or Right Ascension and Declination of any Planet, or Comet, to place it on the Globe, to correspond with its place in Heaven.*

PLANETS and Comets cannot be placed on the *Globe* so as their Places will long retain correspondence with their Places in *Heaven*; Because as was said, Chap. 44. they have a continual Motion from *West* to *East* upon the *Poles* of the *Ecliptick*: yet nevertheless, you may by having their *Longitude* and *Latitude* or *Right Ascension* and *Declination*, for any set Time, place a Mark for them on the *Globe*, either with Ink, if your *Globe* be Varnisht, for then you may with a wet Finger wipe it off again; or with Black-lead, if it be not Varnisht, and then you may rub it out again with a litte White Bread:

Bread : which Mark for that Time, will as effectually serve you to work by, as any of the Fixed Stars placed one the Globe will do.

Therefore if the *Longitude* and *Latitude* of any Planet or Comet be given; do thus, Elevate the *North Pole*, if the *Latitude* given be *North*; but if the *Latitude* given be *South*, Elevate the *South Pole*,  $66\frac{1}{2}$  Degrees; and place the *Pole* of the *Ecliptick* in the *Zenith*, and over it screw the *Quadrant of Altitude* : so shall the *Ecliptick* lye in the *Horizon*; and the *Quadrant of Altitude* being turned about the *Horizon* shall pass through all the Degrees of *Longitude*; Then find the point of given *Longitude* in the *Ecliptick*, and bring it to the *Quadrant of Altitude* and hold it there : Then count upwards on the *Quadrant of Altitude* the number of Degrees and Minutes of Given *Latitude*, and at the point where the number ends close to the *Quadrant of Altitude*, make a small Prick, and that Prick shall represent the Planet or Comet you were to place on the *Globe*.

If it be the *Right Ascension* and *Declination* of a Planet or Comet that is given; you must find the Degree and Minute of *Right Ascension* on the *Equinoctial*, and bring it to the *Meridian*, and keep the *Globe* there steady; then find the Degree and Minute of *Declination* on the *Meridian*, and under that Degree and Minute on the *Globe* make a Prick, and that Prick shall represent the Planet or Comet, as aforesaid.

If it be  $h$  or  $u$  that this Prick is to represent, it may stand on the *Globe* sometimes a Week or a Fortnight, without much difference from the Planets place in Heaven. But if the Prick were to represent the other Planets, you must (in regard of their Swift Motion) alter it very often, especially for the *Moon*; for so Swift is her Motion, that in every Two Hours she Alters about a Degree in *Longitude*.

Having thus placed this Mark on the *Globe*, you may find out the Time of its several Positions and Aspects, if you work by it as you are directed to work by the *Sun*, in the several respective Problemes throughout this Book.

The End of the Second Book.

## The Third BOOK.

Being the Practial Use of the

# GLOBES.

Applied to the Solution of PROBLEMES

IN THE

## Art of Navigation.

### P R Æ F A C E.

BECAUSE the Art of Navigation consists as well in the knowledge of Astronomical and Geographical Problemes, as in Problemes meerly Nautical; Therefore I must desire the Artist to seek in the last Book such Problemes as are only Astronomical or Geographical: For my Design is here to collect such Problemes as are only used in the Art of Navigation: some few particulars excepted, as for finding Latitude, Longitude, Course, Distance, &c. Which though they are handled in that Book; yet for their Utility in the Art of Navigation, and for that what there is Given, cannot always be hid to Work by; therefore in this Book I have mentioned divers other Observations, which being Made or Had, you may by the Rules proper for each Observation Find what shall be Proposed.

P 2

PROB.



## PROB. I.

*The Suns Amplitude and Difference of Ascension given, to find the Height of the Pole, and Declination of the Sun.*

Elevate the Pole so many Degrees as the Difference of the *Suns Ascension* is, and screw the *Quadrant of Altitude* to the *Zenith*, and bring the first point of  $\gamma$  to the *Meridian*; then number on the *Quadrant of Altitude* upwards the Complement to 90 of the *Suns Amplitude*, and move the *Quadrant of Altitude* till that number of Degrees cuts the *Equator*; So shall the *Quadrant* cut in the *Horizon* the Degree of the *Poles Elevation*; and in the *Equator* the Degree of the *Suns Declination*.

*Example.*

The Difference of *Ascension* is 27 Degrees 7 Minutes. Therefore I Elevate the Pole 27 Degrees 7 Minutes Above the *Horizon*, and screw the *Quadrant of Altitude* to 27 Degrees 7 Minutes, which is in the *Zenith*: then I bring the first point of  $\gamma$  to the *Meridian*, and number on the *Quadrant of Altitude* upwards 56 Degrees 40 Minutes, the Complement of the *Suns Amplitude*, and bring that Degree to the *Equator*: then I see in what Degree of the *Horizon* the *Quadrant* cuts the *Horizon*, and find  $51\frac{1}{2}$ , which is the *Elevation* of the Pole: then looking in what Degree of the *Equator* the *Quadrant of Altitude* cuts the *Equator*, I find 20 Degrees 5 Minutes, which is the *Declination* of the Sun at the same Time.

## PROB. II.

*The Suns Declination and Amplitude given, to find the Poles Elevation.*

Elevate The Pole so many Degrees as the Complement of the *Suns Amplitude* is; and screw the *Quadrant of Altitude* in

in the *Zenith*, and bring the first point of  $\gamma$  to the *Meridian*: Then count on the *Quadrant of Altitude* to the Degree of the *Suns Declination*, and bring that Degree to the *Equinoctial*; and the Degree of the *Equinoctial* cut by that Degree of the *Quadrant of Altitude*, is the Degree of the *Poles Elevation*.

*Example.*

The *Suns Amplitude* is 33 Degrees 20 Minutes, his *Declination* is 20 Degrees 5 Minutes, his Complement of *Amplitude* to 90 is 56 Degree 7 Minutes. Therefore I Elevate the Pole 56 Degrees 7 Minutes Above the *Horizon*, and screw the *Quadrant of Altitude* to 56 Degrees 7 Minutes, which is in the *Zenith*: Then I bring the first point of  $\gamma$  to the *Meridian*, and number on the *Quadrant of Altitude* Upward 20 Degrees 5 Minutes for the *Suns Declination*, this 20 Degrees 5 Minutes, I bring to the *Equinoctial*, and find it cut there  $51\frac{1}{2}$  Degrees, for the *Height* of the Pole.

## PROB. III.

*The Suns Declination and Hour at East given, to find the Height of the Pole.*

Elevate the Pole so many Degrees as the *Suns Declination* is, and screw the *Quadrant of Altitude* in the *Zenith*: Then Convert the Hours or Minutes past 6 given into Degrees; by allowing 15 Degrees for every Hour of Time, and for every Minute of Time 15 Minutes of a Degree; and number those Degrees or Minutes in the *Horizon* from the *East Southwards*; and bring the *Quadrant of Altitude* to that Degree, so shall the Degree of the *Quadrant of Altitude* cut by the *Equator* be the Complement of the *Height of the Pole*.

*Example.*

The *Suns Declination* is 20 Degrees 5 Minutes. Therefore I Elevate the Pole 20 Degrees 5 Minutes, and also screw the *Quadrant of Altitude* to 20 Degr. 5 Minutes which is in the *Zenith*: the Hour the Sun comes to be at *East* is 7 a Clock 7 Minutes; that is, 1 Hour 7 Minutes after 6. Therefore I convert 1 Hour 7 Mi-

minutes into Degrees, as before, and it gives 16 Degrees 50 Minutes; which number of Degrees and Minutes I count from the *East* point *Southwards*, and thither I bring the *Quadrant of Altitude*: Then I look in what Degree of the *Quadrant of Altitude* the *Equator* cuts, and find  $38\frac{1}{2}$ , which is the Complement of the *Pole Height*, viz.  $51\frac{1}{2}$  Degrees for the *Height of the Pole*.

In this Probleme the *Declination* of the *Sun* and Elevation of the *Pole* bears the same Denomination of either *North* or *South*, for when the *Declination* and the Elevation are Different, the *Sun* cannot come to the *East* point.

#### PROB. IV.

*The Declination of the Sun and his Altitude at East given to find the Height of the Pole.*

Levate the *Pole* to the Complement of the *Suns Altitude*, and screw the *Quadrant of Altitude* to the *Zenith*: then bring the *Equinoctial* point  $\gamma$  to the *Meridian*, and number on the *Quadrant of Altitude* the Degree of the *Suns Declination*, and bring that Degree to the *Equinoctial*, and note the Degree it Cuts; for its Complement to 90 is the *Height of the Pole*.

#### Example.

May 10. The *Suns Declination* is 20 Degrees 5 Minutes; His *Altitude at East* is 25 Degrees 55 Minutes here at *London*: I enquire the *Height of the Pole*. Therefore I subtract 25 Deg. 55 Min. from 90 the Remains is 64 Deg. 5 Min. for its Complement; wherefore I bring 64 Deg. 5 Min. of the *Meridian* to the *Horizon*; and to 64 Deg. 5 Min. which is in the *Zenith*, I screw the *Quadrant of Altitude*: Then I bring  $\gamma$  to the *Meridian*, and count on the *Quadrant of Altitude* Upwards 20 Deg. 5 Min. and move it about the *Equinoctial* till those 20 Deg. 5 Min. touch the *Equinoctial*, which I find to be in  $38\frac{1}{2}$  Degrees, Therefore I subtract those  $38\frac{1}{2}$  from 90, and the Remains is  $51\frac{1}{2}$  Degrees. Therefore I say the *Pole* here at *London* is Elevated  $51\frac{1}{2}$  Degrees.

The *Declination* and the Elevation is always of the same Denomination *North* or *South*, for when they Alter their Denomination the *Sun at East* can have no *Altitude*, neither can it indeed reach

reach the *East* point: and therefore in this *Example*, because the *Suns Declination* is *North* it is the *North Pole* that is Elevated.

*To perform the same otherwise, with a pair of Compasses*

Take off with your *Compasses* from the *Equator* or *Quadrant of Altitude* the number of Degrees of *Altitude* Observed, and place one Foot at the beginning of  $\gamma$  on the inner edge of the *Horizon*, and extend the other directly Upwards towards the *Zenith*: Then move the *Brazen Meridian* through the Notches of the *Horizon* till the other point of your *Compasses* (respecting the *Zenith*) reach the Parallel of the *Suns Declination*: So shall the number of Degrees on the *Meridian* be the number of Degrees that the *Pole* is Elevated above the *Horizon*; and is either *North* or *South* according as the *Suns Declination* is: as before.

This may yet otherwise be performed with the *Quadrant of Altitude*, by taking the *Nut* off the *Meridian*, and laying the edge of its *Index* (specified in Cap. 1. Sect. 6. of the first Book) exactly on the *East* Line of the *Horizon*: for when that lies straight between the point of *East* on the outer verge of the *Horizon* and the beginning of  $\gamma$  in the inner verge of the *Horizon*, then shall the upper end of the *Quadrant of Altitude* point directly to the *Zenith*: and if then you turn the *Meridian* through the Notches of the *Horizon* till the *Suns Altitude* on the *Quadrant of Altitude* Cuts the Parallel of *Declination*, you will have the end of the *Quadrant of Altitude* on the *Meridian* point to the *Height of the Pole*: as before.

#### PROB. V.

*By the Suns Declination and Azimuth at 6 of the Clock given, to find the Height of the Pole, and Almicanter at six.*

Levate the *Pole* so many Degrees as the *Suns Azimuth* is at 6. and screw the *Quadrant of Altitude* in the *Zenith*, and bring the first point of *Aries* to the *Meridian*: Then number on the *Quadrant of Altitude* Upwards the Complement of the *Suns Declination*, and bring that Degree to the *Equator*: So shall the Degree

Degree of the *Horizon* cut by the *Quadrant of Altitude* be the Complement of the *Poles Elevation*; and the Degree of the *Equator* cut by the *Quadrant of Altitude* shall be the *Almicantar* of the *Sun* at 6 of the Clock.

### Example.

The *Sun's Azimuth* at 6 is  $12\frac{1}{4}$  Degrees: Therefore I Elevate the *Pole*  $12\frac{1}{4}$ , and screw the *Quadrant of Altitude* to  $12\frac{1}{4}$  Degrees which is in the *Zenith*: then I bring the first point of  $\gamma$  to the *Meridian*; The *Sun's Declination* is 20 Deg. 5 Min. Therefore I number on the *Quadrant of Altitude* 69 Deg. 55 Min. which is the Complement of 20 Deg. 5 Min. to 90. this 69 Deg. 55 Min. on the *Quadrant of Altitude* I bring to Cut the *Equator*, and find when 69 Deg. 55 Min. cuts the *Equator*, that the *Quadrant of Altitude* Cuts the *Horizon* in  $38\frac{1}{2}$  Deg. which is the Complement of the *Poles Elevation*: and at the same time the *Quadrant of Altitude* also Cuts the *Equator* in  $15\frac{1}{2}$  Degrees; which is the *Almicantar* or *Altitude* of the *Sun* at 6 a Clock.

### PROB. VI.

*The Day of the Moneth and Hour of the Night given, to find the Height of the Pole, by a known Star Observed Rising or Setting.*

**R**ectifie the *Hour Index*, by Prob. 2. of the former Book; and turn the *Globe Westwards* till the *Hour Index* points at the Hour of the Night; fasten the *Globe* there, and turn the *Meridian* through the Notches of the *Horizon*, till the known *Star* come to the *East side* the *Horizon*, if the *Star* be Rising, or the *West*, if it be Setting; so shall the Degrees of the *Poles Elevation* be Cut by the *Horizon* under the Elevated *Pole*; and is North or South according as the Elevated *Pole* of the *Globe* is.

### PROB. VII.

*Two Places given in the same Latitude, to find the Difference of Longitude.*

**B**ring the first Place to the *Meridian*, and note the number of Degrees of the *Equinoctial* that comes to the *Meridian* with

with it; then bring the other Place to the *Meridian*, and note the number of Degrees of the *Equator* that comes to the *Meridian* with it: and by Subtracting the Lesser number from the greater you have the Difference of *Longitude*. This needs no Example.

### P R O B. VIII.

*Two places given in the same Longitude, to find the Difference of Latitude.*

**B**ring the Places to the *Meridian*, and the Degrees of the *Meridian* over the two Places is the *Latitudes* of them both: and by subtracting the Lesser number of Degrees from the Greater, you will have the Difference of *Latitude*.

### P R O B. IX.

*Course and Distance between two Places given to find their Difference in Longitude and Latitude.*

**S**eck the *Rhumb* you have Sailed upon, as in Prob. 34. of the last Book, and upon that *Rhumb* make a Mark for the Place you Departed from; then with your *Compasses* take off from the *Equinoctial* the number of *Leagues* you have Sailed upon that *Rhumb*, by allowing a Degree for every 20 *Leagues*, and place one Foot of your *Compasses* upon that Mark, and where the other Foot falls on that *Rhumb* make a Second Mark; then by bringing the First Mark to the *Meridian*, you will see on the *Meridian* the *Latitude* of that Mark, and in the *Equator* the *Longitude* as in Prob. 2. of the last Book: and by bringing the Second Mark also to the *Meridian*, you will as before, find the *Longitude* and *Latitude* of the Second Mark also. Then by Subtracting the Lesser *Latitude* from the Greater *Latitude*, and the Lesser *Longitude* from the Greater *Longitude*, you will have the Difference remaining, both of *Longitude* and *Latitude* you are arrived into.

## P R O B. X.

*To find how many Miles are contained in a Degree of any Parallel.*

Every Degree of the *Equinoctial* contains 20 English Leagues, and every League 3 English Miles: But in every *Parallel* to the *Equinoctial* the Degrees diminish more and more even to the *Pole*, where they end in a point. Therefore a Degree in any *Parallel* cannot contain so many Miles as a Degree in the *Equinoctial*. Now that you may know how many Miles are contained in a Degree of any *Parallel* to the *Equinoctial*, Do thus, Measure with your *Compasses* the Width of any number of Degrees in any given *Parallel*; suppose (for Example sake) 10 Degrees in the *Parallel* of  $51\frac{1}{2}$ ; Examine in the *Equator* how many Degrees of the *Equator* they will make, and you will find  $6\frac{1}{2}$ . Therefore 1 Deg. in the *Equator* making 60 Miles,  $6\frac{1}{2}$  Degrees makes 360. to which Add for the  $\frac{1}{2}$  part 12 Miles, makes 372 Miles, to be the Measure of 10 Degrees in the *Parallel* of  $51\frac{1}{2}$ . So that by Dividing 372 by 10, you have 37 Miles for the Length of a Degree, from East to West in the *Parallel* of  $51\frac{1}{2}$  Degrees.

## P R O B. XI.

*The Rhumb you have sailed upon, and the Latitudes you departed from, and are arrived to, given, to find the Difference of Longitude, and the number of Leagues you have Sailed.*

First seek the *Rhumb* you have Sailed on, and pass it through the *Meridian* till it Cuts in the *Meridian* the *Latitude* you Departed from; and keeping the *Globe* there steady, make a Mark close by the *Meridian*, under that *Latitude*, and in that *Rhumb* on the *Globe*, and note in the *Equinoctial* the Degree of *Longitude* at the *Meridian*: then pass that *Rhumb* through the *Meridian* again, till it Cuts in the *Meridian* the *Latitude* you are Arrived to; and in that *Rhumb* and *Latitude* make on the *Globe* another Mark, and examine in the *Equinoctial* the

the *Longitude* of the Second Mark; for the difference between First and Second Mark, is the Difference of *Longitude*; Then open your *Compasses* to one Degree of the *Equinoctial*, and by measuring along in the *Rhumb*, Count how many times that Distance is contained between the two Points in that *Rhumb*, for so many times 20 Leagues is the Distance you have Sailed.

## Example.

I Sail upon the *North-West Rhumb* from the *Latitude* of 10 Degrees, into the *Latitude* of 30 Degrees 40 Minutes. Therefore I find the *North-West Rhumb*, and turn the *Globe* through the *Meridian* till this *Rhumb* Cut the *Meridian* in the first *Latitude*, viz. in 10 Degrees, and directly under 10 Degrees upon the *Rhumb* I make a Prick, and also find 10 Degrees 3 Minutes of the *Equator* at the *Meridian*, for the *Longitude* of the First Place. Then I turn the *Globe* again through the *Meridian*, till the same *Rhumb* Cut the *Meridian* in the Second *Latitude*, viz. in 30 Degrees 40 Minutes, and directly under those 30 Degrees 40 Minutes in the same *Rhumb*, I make another Prick, which represents the Place I am Arrived to: I examine the *Longitude* of this Prick, as before, and find it 32 Degrees 10 Minutes. Therefore I Subtract the First *Longitude*, viz. 10 Degrees 3 Minutes from the second *Longitude*, viz. 32 Degrees 10 Minutes, and there Remains 22 Degrees 7 Minutes, for the Difference of *Longitude*.

Then for Examining the *Distance*, I open my *Compasses* to 1 Degree on the *Equinoctial*, and measure upon the *Rhumb* how oft that Distance is contained between the two Pricks, and find  $29\frac{1}{4}$ , that is, 29 Degrees 15 Minutes, which Multiplied by 20 gives 585 for the number of Leagues Sailed upon that *Rhumb*.

The Reason why I open the *Compasses* no wider than to 1 Degr. is, because the *Rhumbs* being Circular or Crooked Lines, the distance on them may be measured more exactly by often counting that 1 Degr. in them, than if the *Compasses* had bin opened to many Degrees. Thus if the *Compasses* had been opened wide enough to reach between the two Pricks aforesaid, I should not have had above 583 Leagues for the distance between the two places: neither is there indeed more great Circle distance between them; But I Sailed upon a *Rhumb*, that is, I followed

the *Course* of a Circular Winding Line, and so fetch a *Compass* about to come to these two Pricks; and therefore I have in truth Sailed 585 *Leagues*. For the segment of a *Rhumb* between two Places is alwaies greater than a straight Line drawn betwixt them; yea sometimes by Half, or more, in Places neer either *Pole*.

Note, If you be not very curious in opening your *Compasses* to this small distance, you may in oft turning them about upon the *Rhumb* commit error in your Measuring: therefore when you have taken the Distance of one Degree, try if you neither gain or lose any thing in measuring 10, or 20 Degrees of the *Equinoctial* by them for then your *Compasses* are opened to a width exact enough for your purpose.

### PROB. XII.

*The Longitude and Latitude of two Places given, to find Course, and Great Circle Distance between them.*

**F**ind on the *Globe* the *Longitudes* and *Latitudes* given, and make Pricks to either *Longitude* and *Latitude*: if any *Rhumb* pass from one Place to the Other, that is (without more ado) the *Rhumb* sought. But if no *Rhumb* pass through, Take the *Rhumb* that runs most Parallel to the two Pricks: for that shall be the *Rhumb*, or the neerest *Rhumb* that these two Pricks Bear on. An Example of this, see in Prob. 34. of the last Book: And the *Great Circle Distance* between these two Pricks, you may find, as by Prob. 33. of the same Book.

### PROB. XIII.

*The Latitude you departed from, and the Latitude you are arrived to, and the number of Leagues you have sailed given, to find the Rhumb you have sailed on, and Difference of Longitude.*

**M**ake a Prick on the *Globe* in the *Latitude* you departed from: then open your *Compasses* to the number of *Leagues* you have Sailed, by taking for every 20 *Leagues* 1 Degree of the *Equator*, Half a Degree for 10 *Leagues*, a Quarter

Quarter of a Degree for 5 *Leagues*, and so proportionably for any other number of *Leagues*. Place one Foot of your *Compasses* in the Prick made for the *Latitude* you Departed from, and extend the Other towards the *Latitude* you are arrived to, and describe an occult Arch; Turn the *Globe* till this occult Arch come to the *Latitude* on the *Meridian*, and where the *Latitude* Cuts this occult Arch, make another Prick to represent the *Latitude* you are arrived to; so shall the *Rhumb* passing through those two Pricks (or that is most parallel to those two Pricks) be as in the last Prob. the *Course* or the *Rhumb* those two pricks Bears on. The Difference of *Longitude* you may find as by Prob. 14.

### PROB. XIV.

*To find by the Globe the Variation of the Needle; commonly called the Variation of the Compass.*

**O**bserve by a *Compass* whose Wye is placed just under the *Flower-de-luce*, what Point of the *Compass* the *Sun* Rises or Sets on, Morning, or Evening: Then examine by Prob. 10. of the Second Book, what Degree of the *Horizon* the *Sun* Rises or Sets on by the *Globe* also; and if the Rising or Setting be the same, both on the *Globe* and *Compass*, there is no *Variation* in your Place: But if there be Difference between the Rising or Setting by the *Compass* and the *Globe*, then is there *Variation* in your Place.

If the Point the *Sun* Rises upon in the *Compass* be neerer the *North* Point, than the Point the *Sun* Rises upon by the *Globe*, the *Variation* is Eastwards.

If the Point the *Sun* Sets upon in the *Compass* be neerer the *North* than the Point it Sets upon by the *Globe*, the *Variation* is Westwards.

If the Point the *Sun* Sets upon in the *Compass* be further from the *North* Point, than the point the *Sun* Sets upon by the *Globe*, the *Variation* is Eastwards.

If the Point the *Sun* Rises upon in the *Compass* be further from the *North* Point than the Point the *Sun* Rises upon by the *Globe*, the *Variation* is Westwards. And so many Degrees as there is between the Point of Rising or Setting found by the *Compass*, and the point of True Rising or Setting found by the *Globe*, so many

many Degrees is the *Variation* from the *North* towards the *East* or *West* Point.

*Otherwise, when the Sun hath Altitude.*

Having the *Altitude* of the *Sun*; find by Prob. 22. of the Second Book, its *Azimuth*: Then examine by a *Compass* whether the true *Azimuth* found by the *Globe*, agree with the *Azimuth* found by a *Nautical Compass*: If they agree, there is no *Variation*: But if the *Azimuth* of the *Compass* before Noon be nearer the *North* than the true *Azimuth* found by the *Globe*, the *Variation* is Eastwards.

If the *Azimuth* by the *Compass* Afternoon be nearer the *North*, the *Variation* is Westwards.

If the *Azimuth* by the *Compass* Afternoon be further from the *North*, the *Variation* is Eastwards.

If the *Azimuth* by the *Compass* before Noon be further from the *North*, the *Variation* is Westwards.

And this *Variation* shall be as aforelaid, so many Degrees as there is between the *Azimuth*, Observed by the *Compass*, and the true *Azimuth*, Observed by the *Globe*.

#### P R O B. XV.

*To Keep a Journal of the Ships Way by the Globe.*

BY some of these foregoing Problemes you may Daily (when Observations can be made) find both the *Longitude* and *Latitude* on the *Globe* of the Places you are Arrived to, and also the *Way* the Ship hath Made, and make Pricks on the *Globe* in their proper Places for every Days Voyage, so truly and so naturally, that if you Kept your reckoning aright you may be sure you cannot miss any thing of the Truth it self; and that with less Trouble and greater Advantage, than keeping a Book of every Days Reckoning.

P R O B.

#### P R O B. XVI.

*To Steer in the Night by the Stars.*

RECTifie the *Globe* and *Hour Index* as by Prob. 2. of the last Book, and turn about the *Globe* till the Index of the *Hour Circle* points to the Hour of the Day or Night; Then turn the *Globe* till the Difference of *Longitude* between the Place you Depart from, and the place you Sail To, pass through the *Meridian*; and if any *Star* in the *Latitude* of the Place you Sail To, Come to the *Meridian*, or neer the *Meridian* with the Degree of the Difference of *Longitude*, That *Star* is at that Time in or neer the *Zenith* of that Place you Sail to: and by finding the same *Star* in *Heaven*, as by Prob. 44 of the last Book, you may Direct your Ship towards that *Star*, and Sail as confidently (says Mr. Blagrave) as if *Mercurie* were your Guide. But because this *Star* Moves from the *Zenith* of this Place, you must often examine what *Star* is come to the *Zenith*, and so often Change the *Star* you Steer by, as the length of your Voyage may require.

#### P R O B. XVII.

*How to Platt on the Globe New Land, never before Discovered.*

THESE two following Problemes are 2. Chapters of Mr. Wrights, delivered by him as follows.

It may sometimes fall out in New Discoveries, or when your Ship by means of a Tempest is Driven out of her right Course, that you shall come to the sight of some *Ile*, *Shaal*, or *New Land*, whereof the *Mariner* is utterly ignorant: And to make some Relation of the same, or go unto it some other Time, If you desire to Set it down on your *Globe* in the true Place, you may do it after this manner: So soon as you have Sight thereof, mark it well, First with your *Compass*, Observing diligently upon which *Point* thereof it lieth. And secondly, you must theretake the Height of the *Sun*, or of the *Pole-star*, as you were taught Prob. 13. of the Second Book, that you may know in

in what Point your Ship is, and that Point you must call the *First Point*; which being so done, your Ship may Sail on her *Course* all that Day, till the Day following, when losing her *Way*: and the next Day mark the Land again; and see upon what *Point* it lieth; and then take your *height*, and with it *Cast your Point of Traverse* once again: and that you may call your *second Point*. Then take a pair of *Compasses*, and placing one Foot upon the first *Point*, and the Other upon the *Rhumb* towards which the Land did *Bear* when you *Cast your first Point*; Set also one Foot of another pair of *Compasses*, in the *second Point*, and the other foot upon the *Rhumb* upon which the Land lay when you *Cast your Second Point*, and these two *Compasses* thus Opened, you must move by their *Rhumbs*, till those two Feet of both *Compasses* do meet together, which were moved from the foresaid *Two Points*: And where they do so meet together, there may you say is the Land which you *Discovered*; which Land you may Point out with the *In-lets* and *Out-lets* or *Capes*, and other *Signs*, which you saw thereupon. And by the Graduation you may see the *Latitude* thereof, that thereby you may find it, if at any time after you go to Seek for it.

## PROB. XVIII.

*Seeing two known Points or Capes of Land, as you Sail along, how to know the distance of your Ship from them.*

Place one Foot of one pair of *Compasses* upon one of the two foresaid *Capes*, and the other Foot upon the *Rhumb* which in the *Nautical Compass* pointeth towards that *Cape*: And in like manner shall you do with another pair of *Compasses*, placing one Foot thereof upon the other known *Cape*, and the other Foot upon the *Rhumb*, which stretched towards the said *Second Cape*; and moving the two *Compasses* (so opened) by these two *Rhumbs* off from the Land, the very same Point where the two Feet which came from the two *Capes* do meet, you may affirm to be the very Point where your Ship is; And then measuring by the Degrees of the *Equinoctial*, you may see what Distance there is from the said Point to either of the foresaid *Capes*, or to any other Place, which you think good; for it is a very easie matter, if you know the Point where your Ship is.

PROB.

## PROB. XIX.

*Of Tides, and how by help of the Globe you may in general Judge of them.*

Divide the *Equinoctial* into 30 equal parts, as was directed in Prob. 54. of the last Book. These 30 equal parts represent the 30 Daies of the *Moons Age*.

Then on the *North* and *South* Points of the *Compass* in the outmost Verge of the *Horizon*, write with red Ink 12. From the *North Eastward*, viz. at the Point *North* and by *East* write 11  $\frac{1}{2}$ . At the next Point to that the same way, viz. *North North East*, Write 10  $\frac{1}{2}$ . At the next, viz. *North East* and by *North*, Write 9  $\frac{1}{2}$ . And so forward to every Point of the *Compass*; rebating of the last Hour  $\frac{1}{4}$  till you come to 12, in the *South*; where you must begin again to mark that Semi-Circle also in the same Order you did the last. In this Circle is then represented the *Points of the Compass* the *Sun* and *Moon* passeth by every Day; and the Figures annexed represent twice 12 Hours of Day and Night.

Having thus prepared your *Globe* and *Horizon*, you may by having the *Moons Age*, and the *Point of the Compass* on which the *Moon* maketh *Full Sea* at any place given, find at what Hour of Day or Night it shall be *High Tide* in the same place. Thus,

It is a known Rule that a *North* and *South Moon* makes *High Water* at *Margarete*. Therefore Bring the first point of  $\gamma$  to the *North* or *South* Point in the *Horizon*, and Elevate the *North Pole* into the *Zenith*: Then Count in the *Equinoctial*, the Daies of the *Moons Age* numbred in red figures; and the Hour and Minutes written in red figures annexed to the Names of the Winds that stand against the *Moons Age* shall be the Hour of *High Tide* on that Day or Night at *Margarete*.

*The End of the Third Book.*

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## The FOURTH BOOK,

Shewing the Practical Use of the

## GLOBES.

Applying them to the Solution of

## Astrological Problemes.

## P R Æ F A C E.

**T**He Practice of Astrology is grounded upon a twofold Doctrine. The first for Erecting a Figure of Heaven, Placing the Planets in it, Finding what Aspects they Bear each other, and in what Places of Heaven they are constituted, &c. And this we call the Astronomical part of Astrology.

The Second is, How to Judge of the Events of Things by the Figure Erected: and this is indeed the only Astrological part.

The First of these I shall briefly Handle; because what therein is proposed may be performed by the Globe, both with Speed, Ease, Delight, and Demonstration. The Second I shall not meddle with, But refer you to the whole Volumes already Written upon that Subject.

P R O B.

## P R O B. I.

To Erect a Figure of the 12 Houses of Heaven.

**B**Efore you Erect a Figure of the 12 Houses of Heaven it will be requisite you place the Planets,  $\Omega$  and  $\Upsilon$  according to their Longitude and Latitude upon the Globe, as was directed Prob. 55. of the second Book: for then, as you Divide the Houses of your Figure by the Circle of Position, you may by inspection behold in what Houses the Planets are Situated, and also see what Fixed Stars they are Applying to, or Separating from. But to the matter.

There is disagreement between the Ancient and Modern Astrologers, about erecting a Figure of Heaven. Mr. Palmer in his Book of Spherical Problemes Chap. 48. mentions four several Waies, and the Authors that used them: whereof one of them is call the Rational way used by Regiomontanus; and now generally practised by all the Astrologers of this Age. This way the Face of Heaven is divided into Twelve parts, which are called the Twelve Houses of Heaven, numbred from the Ascendent or Angle at East downwards with 1, 2, 3, &c. As in the following Figure.

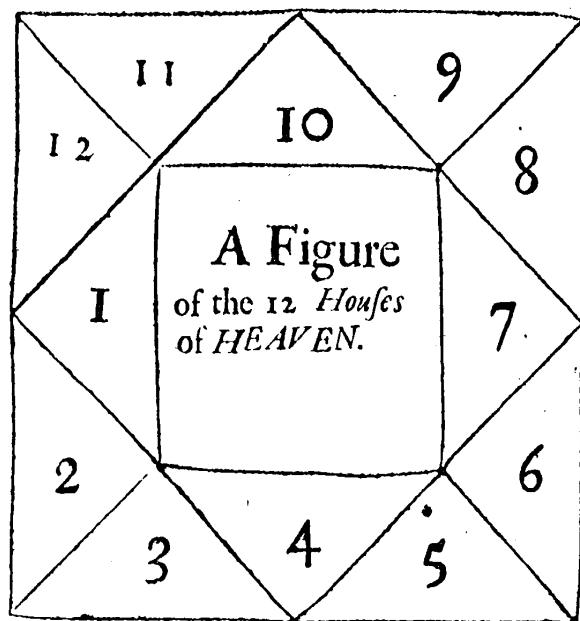
In a Direct Sphere, viz. under the Equator these Twelve Houses are twelve equal parts: But in an Oblique Sphere they are unequal parts, and that more or less according to the quantity of the Spheres Obliquity.

These Twelve Houses are divided by 12 Semi-Circles of Position; which are Semi-Circles passing from the two intersections of the Horizon and Meridian through any Star, Degree or Point in the Heavens.

Four of these Houses are named Cardinals. The First and most Eminent of these Cardinals is the First House, or Angle of East, called the Ascendent; where the Semi-Circle of Position is the same with the Eastern Semi-Circle of the Horizon. The Second Cardinal is the Tenth House or the Angle of South; called Medium Cali, or Culmen Cali, where the Semi-Circle of Position is the same with the Semi-Circle of the Meridian above the Horizon. The Third Cardinal is the Seventh House, or the Angle of West; called the Descendent, where the Semi-Circle of Position is the same with the Western Semi-Circle of the Hori-

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zon. The Fourth Cardinal is the Fourth House, or Angle of North; called *Imum Cæli*, where the Semi-Circle of Position is the same with the Semi-Circle of the Meridian under the Horizon.

The Degrees and Minutes of the *Ecliptick* upon the *Cusps* of these Four Houses (that is, upon the beginning of these Houses) are found all at once; only by bringing the Rising Deg. of the *Ecliptick* to the Horizon: (for the Horizon represents the *Cusp* of the *Ascendent*) and then shall the Meridian Cut the Deg. of the *Ecliptick* on the *Cusp* of the Tenth House. The Western Semi-circle of the Horizon shall cut the Deg. of the *Ecliptick* on the *Cusp* of the Seventh House; and the Semi-Circle of the Meridian under the Horizon shall Cut the Degree of the *Ecliptick* on the *Cusp* of the Fourth House.

If you have the Day of the Month you may by Prob. 3. of the

the Second Book find the *Sun's* Place; and if you have the Hour of the Day, you may, by first Rectifying the *Globe*, as by Prob. 2. of the same Book, turn about the *Globe* till the *Index* of the *Hour-Circle* point to the same Hour in the *Hour-Circle*, and you will then at the Eastern Semi-Circle of the *Horizon* have the Degree of the *Ecliptick* that is Rising, and by Consequence (as aforesaid) all the *Cardinal Points* in their respective Places.

Now to find what Degree of the *Ecliptick* occupies the *Cusps* of the other Eight Houses of Heaven; Do thus, The *Globe* Rectified, as aforesaid, Move the Semi-Circle of Position upwards still 30 Degrees of the *Equator* shall be contained between it and the Eastern Semi-Circle of the *Horizon*; so shall the Semi-Circle of Position Cut in the *Ecliptick* the Degree and Minute of the *Ecliptick* on the *Cusp* of the Twelfth House; and its Opposite Degree and Minute in the *Ecliptick* shall be the *Cusp* of the Sixth House (for you must note that if you have but the Deg. and Minute of the *Ecliptick* upon the *Cusps* of Six of the Houses, the Opposite Degrees and Minutes of the *Ecliptick* shall immediately possess the *Cusp* of every Opposite House.

Then move the Circle of Position over 30 Degrees more of the *Equinoctial*, so shall the Degree of the *Ecliptick* Cut by the Circle of Position be the Degree of the *Ecliptick* upon the *Cusp* of the Eleventh House; and its Opposite Degree in the *Ecliptick* shall be upon the *Cusp* of the Fifth House. The Degree of the *Ecliptick* upon the *Cusp* of the Tenth and Fourth Houses was found as before. Then remove the Circle of Position to the Western side of the Meridian, and let it fall towards the Horizon till 30 Degrees of the *Equator* are contained between the Meridian and it, so shall the Deg. of the *Ecliptick* Cut by the Semi-Circle of Position be the Degree of the *Ecliptick* on the *Cusp* of the Ninth House; and the Opposite Degree of the *Ecliptick* shall be upon the *Cusp* of the Third House. Let the Semi-Circle of Position fall yet lower, till it pass over 30 Degrees more of the *Equator*, so shall the Degree of the *Ecliptick* Cut by the Semi-Circle of Position be the Degree of the *Ecliptick* on the *Cusp* of the Eighth House; and the Opposite Degree of the *Ecliptick* shall be upon the *Cusp* of the Second House. The Degrees of the *Ecliptick* on the *Cusp* of the Seventh House, and *Ascendent* were found as before.

Example

## Example.

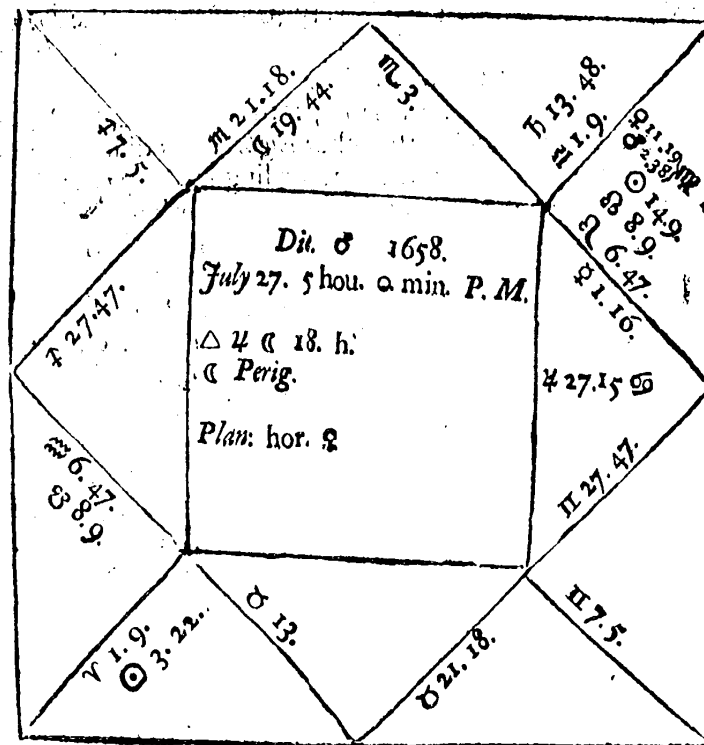
I would Erect a *Figure of Heaven* for *July 27 .5. Hours, 0 Minutes Afternoon, 1658, in the Latitude of London, viz. 51.½ Degrees, North Latitude.*

I first place the *Planets, ♀, and ☿* on the *Globe*, as by Prob. 55. of the second Book was directed: yet not exactly as I find them in the *Ephemeris*, for that shews only their place in the *Ecliptick* at Noon: Therefore I consider how many Degrees or Minutes each *Planets* Motion is in a whole Day or 24 Hours, by Subtracting the *Ecliptical* Degrees and Minutes of the *Planets* place that Day at Noon from the *Ecliptical* Degrees and Minutes of the *Planets* place the next day at Noon: or contrarily if the *Planets* be *Retrograde*: for the Remains of those Degrees and Minutes is the Motion of the *Planet* that Day; Therefore proportionably to that Motion I place the *Planet* forward in the *Ecliptick*: (or backwards if it be *Retrograde*.) As if the *Sun* should move forwards 1 Degree, that is 60 Minutes in a whole Day, or 24 Hours, then in 12 Hours he should move 30 Minutes, in 6 Hours 15 Minutes, in 4 Hours 10 Minutes, in 1 Hour 2½ Minutes, and so Proportionably for any other Space of Time: which I consider before I place the *Planets* on the *Globe*.

Having thus placed the *Planets* on the *Globe*, I Elevate the *North Pole* 51½ Degrees above the *Horizon*, and find the *Sun's* place by Prob. 3. Book 2. to be in ♀ 14 Degrees 9 Minutes, Therefore I bring ♀ 14 Degrees 9 Minutes to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. Then I turn the *Globe Westward*, because it is *Afternoon*, till the *Index* point to 5 Hours *Afternoon*, and with a *Quill* I fasten the *Globe* in this Position: Then I examine what Deg. of the *Ecliptick* is at the *Ascendent* or *Horizon*, and find ♄ 27 47 to which *Sign, Degree* and *Minute* ♄ 27 47 is Opposite; and therefore, as aforesaid upon the *Cusp* of the *Seventh House*: Lifting up the *Circle of Position* till it pass over 30 Degrees of the *Equator* from the *Horizon* upwards I find ♄ 75 Cut by it in the *Ecliptick*, which is the *Sign, Deg. and Minute* upon the *Cusp* of the *Twelfth House*, and its Opposite *Sign, Degree and Minute* is ♄ 7 5, which is upon the *Cusp* of the *Sixth House*: Then lifting up the *Circle of Position* again till it pass over 30 Degrees more of the *Equinoctial*, I find

Cut

Cut by the *Circle of position* ♄ 21 18 which is the *Sign, Degree, and Minute* upon the *Cusp* of the *Eleventh House*, and its Opposite *Sign, Deg. and Minute* is ♄ 21 18 which is upon the *Cusp* of the *Fifth House*, ♄ 3 20 is at the *Meridian*, which is the *Cusp* of the *Tenth House*, and the *Sign, Deg. and Minute* Opposite to it is ♄ 3 20 which is on the *Cusp* of the *Fourth House*. Then taking the *Semi-Circle of position* off its Poles, I place it in the *West* side the *Meridian*, and let it fall towards the *Horizon* till it pass over 30 Degrees of the *Equator* from the *Meridian*, and find the *Circle of Position* cut the *Ecliptick* in ♄ 19 which is the *Sign, Deg. and Minute* on the *Cusp* of the *Ninth House*, Opposite to ♄ 19 is ♄ 19 therefore ♄ 19 is upon the *Cusp* of the *Third House*: Letting the *Circle of Position* fall yet lower till it passes over 30 Degrees more of the *Equator*, I find it Cut the *Ecliptick* in ♄ 6 47 which is the *Sign, Degree and Minute* up-



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on the *Cusp* of the *Eighth House*; and its *Opposite Sign Degree and Minute* is  $\approx 6,47$  which is upon the *Cusp* of the *Second House*; So have you a *Figure* of the *Face of Heaven*; which if you have future use for, you may set down the several *Characters* in the proper places of a *Figure*, as they are on the other side the *Leaf*.

## PROB. II.

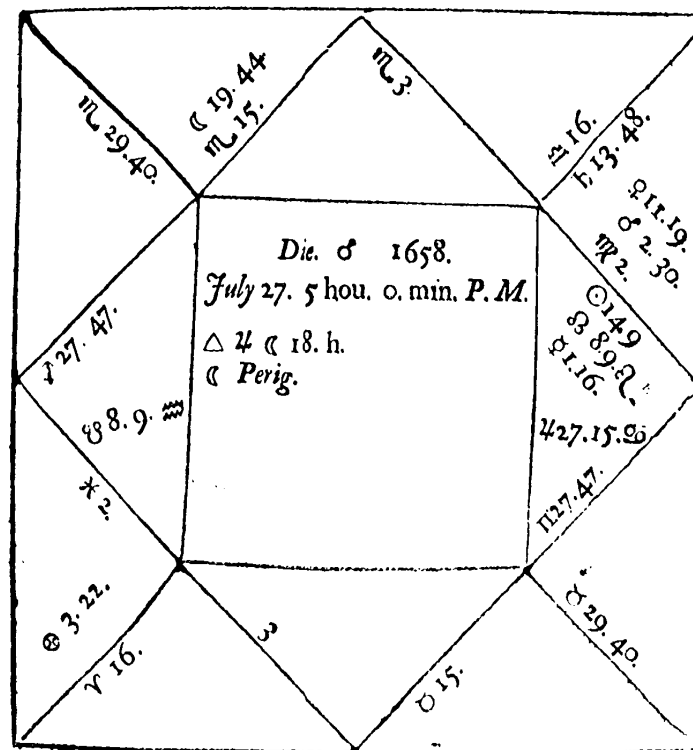
To erect a *Figure of Heaven* according to *Campanus*.

**R**egiomontanus (as aforesaid) makes the beginning of every *House* to be the *Semi-Circle* drawn by the side of the *Semi-Circle of Position* according to the succession of every 30<sup>th</sup> Deg. of the *Equator* from the *Horizon*. But *Campanus* makes it to be the *Semi-Circle* drawn by the side of the *Semi-Circle of Position* according to the Succession of every 30<sup>th</sup> Degree of the *Prime Verticle* or *East Azimuth*, which is represented by the *Quadrant of Altitude* placed at the *East Point*.

The four *Cardinals* are the same, both according to *Regiomontanus* and *Campanus*, but the other *Eight Houses* differ. Therefore when you would find them according to *Campanus*; Rectifie the *Globe* and *Quadrant of Altitude*, and bring the lower end of the *Quadrant of Altitude* to the *East Point* in the *Horizon*: then count from the *Horizon* upwards 30 Degrees on the *Quadrant of Altitude*, and bringing the *Circle of Position* to those 30 Degrees, examine where the *Circle of Position* Cuts the *Ecliptick*; which at the aforesaid Time is in  $\approx 29,40$  for that Deg. and Min. is upon the *Cusp* of the *Twelfth House*, and its *Opposite Deg. and Min.* in the *Ecliptick* viz.  $\approx 29,40$  is upon the *Cusp* of the *Sixth House*: Lift up the *Circle of Position* 30 Degrees higher upon the *Quadrant of Altitude* (viz. to 60 Degrees) and the *Circle of Position* will Cut the *Ecliptick* in  $\approx 15$  Degrees for the *Cusp* of *Eleventh House*, and its *Opposite Deg. and Minute* in the *Ecliptick* viz.  $\approx 15$  is upon the *Cusp* of the *Fifth House*. The Degree and Minute of the *Ecliptick* on the *Cusp* of the *Tenth* and *Fourth Houses* is at the *Meridian*.

Then transferring the *Circle of Position* to the *West* side of the *Meridian*, and the *Quadrant of Altitude* to the *West Point* in the *Horizon*; Let the *Semi-Circle of Position* fall 30 Degrees from the *Meridian* of the *Quadrant of Altitude*, and it will Cut in the *Ecliptick*

*cliptick*  $\approx 16$  Degrees, for the *Cusp* of the *Ninth House*, and its *Opposite Degree and Minute* in the *Ecliptick*, viz.  $\approx 16$  is upon the *Cusp* of the *Third House*: Let fall the *Circle of Position* 30 Degrees lower on the *Quadrant of Altitude*, and it will Cut the *Ecliptick* in  $\approx 2$  Degrees for the *Cusp* of the *Eighth House*, and its *Opposite Degree*, viz.  $\approx 2$  Degrees is on the *Cusp* of the *Second House*: The *Cusps* of the *Seventh* and *Ascendant* is the same with *Regiomontanus* viz.  $27,47$  and  $7,27,47$ . The *Figure* follows.



## PROB. III.

To find the Length of a Planetary Hour.

**A**strologers divide the Artificial day (be it long or short) into 12 equal parts, and the Night into 12 equal parts: These parts they call *Planetary Hours*. The

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First of these *Planetary Hours* takes its Denomination from the *Planetary Day*; and the rest are named orderly from that *Planet* according to the succession of the *Planetary Orbs*. As if it be *Munday* that is, the *Moons Day* (as by Prob. 42, of the Second Book) the *Planet* Reigning the First Hour shall be  $\delta$ , the *Planet* Ruling the Second Hour shall be  $\epsilon$ , the third *Planetary Hour* shall be  $\gamma$ , the fourth  $\delta$ , the Fifth  $\zeta$ , the Sixth  $\eta$ , the Seventh  $\theta$ . Then begin again with  $\alpha$  for the Eighth *Planetary Hour*,  $\beta$  for the Ninth, and so through the whole *Day* and *Night*, till the *Sun* Rise again the next *Day*.

The Length of this *Planetary Hour* is found by the *Globe* thus, The *Globe* Rectified; Bring the *Sun's* Place to the *East* side the *Horizon*, and make a Prick at the Degree of the *Equator* that comes to the *Horizon*, with it. Then remove the *Sun's* place to the *Meridian*, and count the number of Degrees of the *Equator* comprehended between that Prick and the Deg. now at the *Horizon*; and divide that number of Degrees and Minutes by 6, because there is 6 *Planetary Hours* past since Noon; and the Quotient shall shew the number of Degrees and Minutes that pass through the *Meridian* in one *Planetary Hour*.

### Example.

July 27. I would know the Length of a *Planetary Hour* here at *London*; I Rectify the *Globe*, and bring the *Sun's* place, viz.  $\alpha$  13.50 to the *Eastern* side the *Horizon*, and find 115 Degrees of the *Equator* come to the *Horizon* with it, to this 115. Degrees I make a Prick: Then I turn the *Sun's* place to the *Meridian*, and find 226 Degrees of the *Equator* at the *Horizon*. Therefore I either count the number of Degrees between the Pricks at the Deg. of the *Equator* at the *Horizon*, or else subtract the Lessor from the greater, but both waies I find 111 Degrees of the *Equator* to pass through the *Meridian* (or the *Horizon*) in six *Planetary Hours*: therefore dividing 111 by 6 I find 18 Deg. 30 Min. of the *Equator* to pass through the *Meridian* in one *Planetary Hour*; which 18 Degrees 30 Minutes reduced into *Time*, yields 74 Minutes by accounting for every 15 Degrees one Hour, for 1 Deg. 4 Minutes, and for Half a Deg. 2 Minutes of *Time*, and so proportionably; so that the Length of a *Planetary Hour*, July 27 is 1 common Hour and 14 Minutes here at *London*.

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### P R O B. IV.

*The Length of a Planetary Hour known, to find what Planet Reigneth any given Hour of the Day or Night.*

THE *Globe* Rectified as in the last Probleme, Turn about the *Globe* till the *Index* of the *Hour-Circle* points to the Hour of the Day in the *Hour-Circle*. Then count the number of Degrees comprehended between the Deg. of the *Equator* at the *Horizon*, and the Prick in the *Equator*, made as in the last Probleme, and reduce that number of Degrees into Minutes of *Time*, by Reckoning 4 Minutes of *Time* for every Deg. of the *Equator*. Reduce also the number of Degrees and Minutes that pass through the *Meridian* in one *Planetary Hour* into Minutes, by allowing (as aforesaid) 4 Minutes for every Deg. and then divide the First number by the Second, and the Quotient shall be the number of *Planetary Hours* since *Sun* Rising. Having the number of *Planetary Hours* since *Sun* Rising, Reckon the First *Planetary Hour* by the name of that *Planet* that bears the Denomination of the Day, the Second *Planetary Hour* by the *Planet* succeeding that in order, the third by the next in Order, and so for all the rest till you come to the last *Planet*, viz.  $\epsilon$ ; and then begin again with  $\delta$ , and so to  $\gamma$  &c. till you have reckoned so many *Planets* as there are *Planetary Hours* since Morning; and that *Planet* the number ends on, shall be the *Planet* Reigning that *Planetary Hour*.

### Example.

July 27. as aforesaid, I would know what *Planet* Rules at 5 a Clock past Noon: The Length of the *Planetary Hour* this Day (found by the last Probleme) is 1 Hour 14 Minutes: Therefore the *Globe* Rectified, I bring the *Index* of the *Hour-Circle*, to the Hour of the Day, viz. 5 a Clock in the *Hour-Circle*, and then count the number of Degrees between the Prick made, as by the last Probleme, and the Deg. of the *Equator* at the *Horizon*, and find them 187 which I reduce into Minutes, by allowing for every Deg. 4 Minutes; and that gives 748 Minutes. This 748 Minutes I divide by the Minutes contained in one *Planetary*

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ry Hour this Day, viz. by 72, and find 10 Hours 8 Minutes which shews there are 10 Planetary Hours and 8 Minutes past and go 10 since Sun Rising. Therefore  $\delta$  being the Planet after whose name the Day is called, viz. *Dies Partis*,  $\delta$  is as aforesaid, the Ruler of the First Planetary Hour: From him I count the Planet succeeding, which is  $\cdot$  for the Second Hour; from  $\cdot$  I count the Planet succeeding, which is  $\gamma$  for the Third Hour; and so on to  $\psi$  and  $\zeta$ : and then I begin the Round again with  $\cdot$ ,  $\gamma$ ,  $\delta$ , and  $\zeta$ , till I come again to  $\gamma$ , which is the Tenth Planetary Hour since Sun Rising; and the Minutes Remaining being 8 shews that there is 8 Minutes past since she began to Reign.

## PROB. V.

To find Part of Fortune by the Globe.

Count the number of Degrees and Minutes contained between the Sun's place and the Moon's place, beginning at the Sun's place and counting according to the succession of Signs till you come to the Moon's place, and having found that number of Degrees and Minutes Add them to the number of Degrees and Minutes Ascending, reckoned from the first point of  $\gamma$ . If the sum Exceed 360 cast away 360, and the Remainder shall be the number of Degrees and Minutes from the first point in  $\gamma$ , in which Part of Fortune falls. But if it do not Exceed 360 You have already the number of Degrees and Minutes from the first point of  $\gamma$  in which you must place Part of Fortune.

## Example.

I would find the place of Part of Fortune for the Time of our Figure: I seek the two Pricks representing  $\odot$  and  $\zeta$ , and find  $\odot$  in  $\Omega$  14 9 and in  $\mathcal{M}$  19 44 therefore counting from the Sun's place to the Moon's place according to the succession of Signs, I find 95 Degrees 35 Minutes contained between them: This 95 Degrees 35 Minutes I Add to 267 Degrees 47 Minutes, the Degree and Minute contained between the first point of  $\gamma$ , and the Ascendent, and they make together 363 Degrees 22 Minutes. This Exceeds 360 therefore I cast away 360 and the remains are 3 Degrees 22 Minutes, for the place in the Ecliptick of Part of Fortune, reckoned from the first point of  $\gamma$ . Therefore

Therefore this Character  $\odot$  which represents part of Fortune, I set in its proper place of the Figure, as I did the Planets.

## PROB. VI.

To find in what Circle of Position any Star, or any Degree of the Ecliptick is.

Circles of Position are numbred from the Horizon upward upon the Quadrant of Altitude placed at the East or West point of the Horizon. Therefore when you would find what Circle of Position any Star or Degree of the Ecliptick is in, Rectifie the Globe and Quadrant of Altitude, and bring the lower end of the Quadrant of Altitude to the East or West point of the Horizon, and lift up the Circle of Position till it come to the Star or Degree of the Ecliptick proposed, and the number of Degrees the Circle of Position then Cuts in the Quadrant of Altitude is the number of the Circle of Position that the Star or Degree of the Ecliptick is in. If the Star or Deg. of the Ecliptick be under the Horizon, turn the Globe about till 108 Degrees of the Equator pass through the Meridian, then will the Star or Deg. of the Ecliptick be above the Horizon: Lift up then the Circle of Position (as before) to the Star or Deg. of the Ecliptick, and the number of Degrees of the Quadrant of Altitude the Circle of Position Cuts on the East side, is the number of Circles of Position the Star was under the Horizon on the West side: or so many Degrees as the Circle of Position Cuts on the Quadrant of Altitude in the West side the Horizon is the number of the Circles of Position the Star or Degree of the Ecliptick was under the Horizon on the East side.

## PROB. VII.

To find the Right Ascensions, the Oblique Ascensions, and the Declinations of the Planets.

Examine the Right Ascensions and Declinations of those Pricks made to represent each Planet, in Prob. 1. of this Book; and work by them as you were directed to work by the Sun, in Prob. 26, 27, 28. of the Second Book.

PROB.

## PROB. VIII.

*How to Direct a Figure by the Globe.*

**T**O Direct a Figure is to Examine how many Degrees of the *Equinoctial* are moved *Eastwards* or *Westwards*, while any Planet or Star in one House comes to the *Cusp* or any other Point of any other House.

When you would Direct any Promittor to any Hylegiacal Point, examine the Degree of the *Equator* at the *Meridian*; then turn about the *Globe* till the Promittor come to the Hylegiacal Point, and examine again the Degree of the *Equator* at the *Meridian*: and by subtracting the Lesser from the Greater you will have the number of Degrees that passed through the *Meridian* while the Place of the Promittor was brought to the Hylegiacal Point: and that number of Degrees shall be the *Arch of Direction*.

## Example.

I would Direct the Body of the *Moon* in our Figure aforesaid to *Medium Cali* or the *Tenth House*: I find by the *Globe* 203 Degrees 30 Minutes of the *Equator* at the *Meridian* with the *Tenth House*, and turning the *Globe* till the Prick made to represent the *Moon* come to the *Meridian*, I find 227 Degrees 20 Minutes of the *Equator* come to the *Meridian* with it; Therefore I Subtract the Lesser from the Greater, viz. 203 Degrees 30 Minutes, from 227 Degrees 20 Minutes, and have remaining 23 Degrees 50 Minutes.

This 23 Degrees 50 Minutes shews that 23 Years 10 Months must expire ere the Effects promised by the Moons present Position shall Operate upon the Signification of the *Tenth House*.

If the Body of the *Moon* had been Directed to any other Point than the *Meridian* or *Horizon*, you must have Elevated the *Circle of Position* to the Point proposed; and have under-proped it to that Elevation, and then have turned about the *Globe* till the Prick representing the *Moon* had come to the *Circle of Position*; and then the Degrees of the *Equator* that should have passed

passed through the *Meridian* while this Motion was making, should be the number of Degrees of *Direction*; and signifie in Time as aforesaid.

## PROB. IX.

*Of revolutions: and how they are found by the Globe.*

**B**Y a Revolution is meant the Annual conversion of the *Sun* to the same Place he was in at the *Radix* of any Business. When you would find a Revolution by the *Globe*, first find the *Right Ascension* of *Mid-Heaven* at the *Radix* of the Business, as by Prob. 26. of the Second Book you were directed to find the *Right Ascension* of the *Sun*; and to it Add 87 Degrees for every Year since the *Radix*: Then Subtract 360 so oft as you can from the Whole and the Remains shall be the *Right Ascension* of *Mid-Heaven* for the Annual Revolution.

If you count the number of Degrees of the *Equator* contained between the *Right Ascension* of the *Mid-Heaven* and the *Right Ascension* of the *Sun*, and convert that number of Degrees into Time, by allowing for every 15 Degrees 1 Hour of Time, it will shew, if the *Sun*'s Place be on the *Western* side of the *Meridian*, the number of Hours and Minutes Afternoon the Revolution shall happen on; but if on the *East*-side the *Meridian*, the number of Hours and Minutes Beforenoon the Revolution shall happen on.

## PROB. X

*How a Figure of Heaven may be Erected by the Revolution thus found.*

**S**Eek the Degree of *Right Ascension* of *Mid-Heaven*, and bring it to the *Meridian*, so shall the Four Cardinal points of the *Globe* be the same with the Four Cardinal Points in Heaven at the Time of the Revolution. The other Houses are found by the *Circle of Position*: as in the first Probleme of this Book.

*The End of the Fourth Book.*



# THE FIFTH BOOK.

Shewin the Practical Use of the

# GLOBES.

Applying them to the Solution of

## Gnomonical Problemes.

### P R Æ F A C E.

**D**YALS are of two Sorts, Pendent, and Fixed. Pendent are such as are Hung by the Hand and Turned towards the Sun; that by its Beams darting through small Pin-holes made for that purpose, the Hour of the Day may be found. These are of two Sorts, Universal, and Particular.

Universal Dials are those commonly called Equinoctial or Ring-Dials: They are Used by Sea-men and Travellers, that often shift Latitudes.

Particular are such as are made and only serve for Particular Latitudes. Of these Sorts are the several Dyals described on Quadrants, Cylinders, &c.

Fixed Dyals shall be the matter of this Discourse; and they are such as are made upon Fixed Plains, and shew the Hour of the Day by a Stile, or Gnomon made Parallel to the Axis of the World.

Of

Of the several Kinds of Dyal Plains: and how you may know them.

A Plain in Dyalling is that Flat whereon a Dyal is Described.

There is some disagreement among Old and Later Authors in the Naming of Plains: for some Name them according to the Great Circle in Heaven they Ly in, and others according to the Situation of the Poles of the Plains. Thus they which Name them according to the Great Circle in Heaven their Plains Ly in, Call that an Horizontal Plain, which others call a Vertical Plain, those Vertical Plains, which others will Call Horizontal; and those Polar, which others Call Equinoctial.

Howe they be Called it matters not, so you can but distinguish their Kinds, which with a little Consideration you may easily learn to do: For remembring but upon what Grounds either the Older or Later Authors gave their Plains their Names, upon the same Grounds you may also learn to know them. I confess both ways admit of some just Exception against, for in the Older Rule a Plain about the Pole, is called an Equinoctial Plain; when as to a sudden apprehension it will Sound more Significant to Call it a Polar Plain, as Later Authors do: Again, Later Authors Call an Horizontal Plain a Vertical Plain; when as it Sounds more Significant to Call it an Horizontal Plain, as Older Authors do: Because it lies Flat upon the Horizon: But I shall give you the Names according to both Rules, and leave you to your liberty to accept of which you please.

First therefore, you have an Equinoctial Plain, or otherwise called a Polar Plain. This Plain hath two Faces, Upper and Under: These two Faces ly in the Plain of the Equinoctial, the Upper Face beholding the Elevated Pole, the Under Face the Depressed Pole.

2. An Horizontal Plain, otherwise Called a Vertical Plain: it lies in the Plain of the Horizon, directly beholding the Zenith.

Erect Plains, otherwise called Horizontal Plains, are the Sides of Walls, and these are of seven Sorts, viz. 1. Erect Direct Vertical, North or South, 2. Erect Direct, East or West. 3. Erect Vertical Declining, 4. Erect Inclining Direct. 5. Erect Inclining Declining. 6. Erect Reclining Direct. 7. Erect Reclining Declining.

3. Erect Vertical, North or South Direct; otherwise Called  
T Direct

*Direct North or South Horizontals*, behold the *North or South Directly*, and ly in the *East or West Azimuth*.

4. *Erect Direct East or West*, otherwise Called *Direct East or West Equinoctials*, behold the *East or West Directly*, and lies in the *Plain of the Meridian*, having its *Poles* in the *Equinoctial*.

5. *Erect Vertical Declining Plains*, otherwise Called *Declining Horizontals*, do not behold the *North or South Directly*, but swerves from them so much as the *Azimuth Parallel* to their *Plains* swerves or *Declines* from them.

6. *Erect Inclining Direct Plains*, have the *Upper side* of their *Plains Inclining* or coming towards you, and their *Plains* do exactly behold either the *East, West, North, or South*.

7. *Erect Reclining Direct Plains*, have the *Upper side* of their *Plains Reclining* or falling from you, and their *Plains* exactly beholding either the *East, West, North, or South*.

8. *Erect Reclining Declining, or Erect Inclining Declining Plains*, are those *Plains*, which are either *Inclining* or *Reclining*, but do not behold the *East, West, North, or South Directly*, but swerve or *Decline* more or less from them.

9. *Polar Plains* are *Parallel* to the *Axis* of the *World*, and to the *Meridians* that *Cuts* the *East, and West, or North and South Points* of the *Horizon*.

All these kinds of *Plains* have two *Faces*; the one beholding the *North Pole* with the same respect that the other beholds the *South Pole*; except the *Equinoctial Plain*, which because neither *Pole* is *Elevated*, hath but one *Face*: yet that one contains as many *Hour Lines* as two other *Faces*.

These two *Faces* or *Plains* will receive just 24 *Hour-Lines*, for the 24 *Hour-Lines* of *Day and Night*: for so much as the one *Side* or *Face* wanteth or exceedeth 12, the other *Side* shall either exceed or want of 12.

Every *Dyal Plain* is *Parallel* to the *Horizon* of some *Countrey* or other of the *Earth*: therefore a *Dyal* made for any *Horizon* of the *Earth* may be *Set* to such a *Position* that it will shew you the *Hour of the Day* in your own *Habitation*: at least for so long as the *Sun* continues upon that *Plain*.

All *Plains* may be aptly demonstrated by the *Globe*, by setting it correspondent to all the *Circles in Heaven*, as by *Prob. 2.* of the *Second Book*: for if you imagine the *Globe* in that *Position* were preſt flat into the *Plain* of any *Circle*, that *Flat* shall

repre-

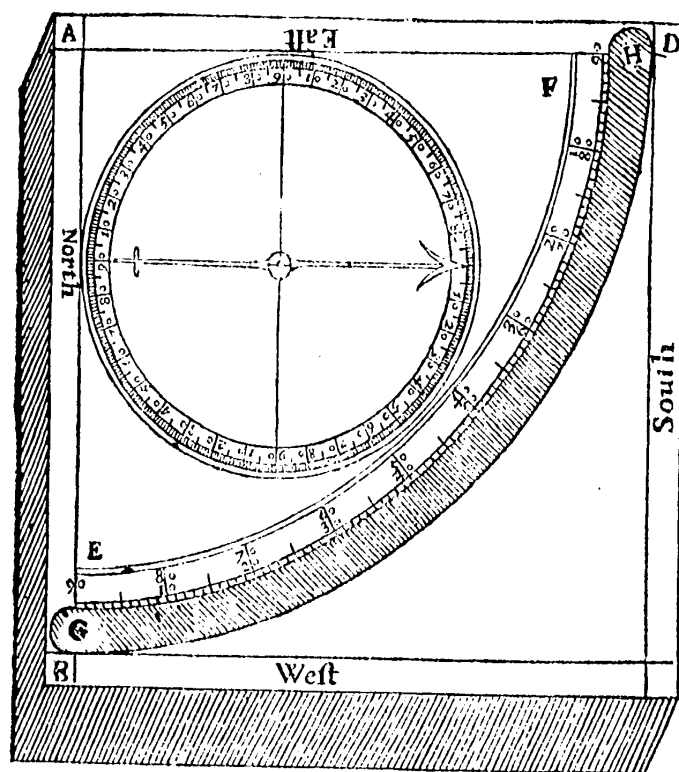
represent a *Dyal plain*, which shall be Called after the Name of that *Circle* it is preſt into.

Thus if the *Quadrant of Altitude* be applyed to any *Degree of Azimuth*, and you imagine the *Globe* were preſt Flat to the edge of the *Quadrant of Altitude*, so much as that *Azimuth Declines* from the *East, West, North, or South*, in the *Horizon*, so much shall that *Flat* on the *Globe* be said to *Decline* either from the *East, West, North, or South*. Or if you imagine the *Globe* were preſt Flat down even with the *Plain* of the *Horizon*, that *Flat* shall represent an *Horizontal Plain*; because as was said before, the *Plain* lies in that *Circle* called the *Horizon*.

The *Style* or *Gnomon* is that straight *Wyer* that casts the *Shadow* upon the *Hour of the Day*: it is always placed *Parallel* to the *Axis* of the *World*.

There are several ways to find the *Situation* of all *Plains*; but the *Readiest* and *Speediest* is by a *Clinatory*. The *Clinatory* is made of a *Square Board*, as *ABCD*, of a good thickness, and the larger the better; between two of the *Sides* is described on the *Center A* a *Quadrant* as *EF* divided into 90 equal parts or *Degrees*, which are figured with 10, 20, 30, to 90; and then back again with the *Complements* of the same *Numbers* to 90: between the *Limb* and the two *Semi-diameters* is made a *Round Box*, into which a *Magnetical Needle* is fitted; and a *Card* of the *Sea Compass*, divided into 4 *Nineties*, beginning their *Numbers* at the *East, West, North, and South Points* of the *Compass*, from which *Points* the opposite *Sides* of the *Clinatory* receive their Names of *East, West, North, and South*. Upon the *Center A* whereon the *Quadrant* was described is fastened a *Plumb-line*, having a *Plumbet* of *Lead* or *Brass* fastned to the end of it, which *Plumb-line* is of such *Length* that the *Plumbet* may fall just into the *Groove GH* below the *Quadrant*, which is for that purpose made of such a *Depth* that the *Plumbet* may ride freely within it, without stopping at the *Sides* of it. See the *Figure* annexed.

With this *Clinatory* you may *Examine* the *Situation* of *Plains*: As if your *Plain* be *Horizontal*; it is *Direct*: And then for the true *Situating* your *Dyal* you have only the true *North* and *South Line* to find: which is done only by setting the *Clinatory* flat down upon the *Plain*, and turning it towards the *Right* or *Left Hand*, till you can bring the *North Point* of the *Needle* to *Hang*



just over the *Flower-de-luce*, for then if you draw a Line by either of the Sides Parallel to the *Needle*, that Line shall be a *North* and *South* Line. But herein respect must be had to the *Variation* of the *Compass* in the Place you make your *Dial*: for if the *North* Point of the *Needle* swerves from the *North* Point of the *World*, then have you not a true *North* and *South* Line. But if in your Place there be no *Variation* of the *North* Point of the *Needle* from the *North* Point of the *World* (as now it happens here at *London*) then the Line drawn by the Side of the *Climatory* (as aforesaid) shall be a true *North* and *South* Line.

But admit there be *Variation*, Having by Prob. 19. of the Third Book found the number of Degrees of this *Variation* toward the *East* or *West*, Count the same number of Degrees from the

the *North* Point in the *Card* either to the *Eastwards* or *Westwards*; and note the Degree in the *Card* terminating at that Number, for that Degree shall be the *North* Point, and its Opposite Degree the *South* Point: 90 Degrees from it either way shall be the *East* and *West* Points.

Therefore, whereas before you were directed to turn the *Climatory*, till the *North* Point of the *Needle* point to the *Flower-de-luce* on the *Card*, you must now turn (or move) the *Climatory* till the *North* Point of the *Needle* Hang just over the Degree of *Variation* thus found; and then a Line drawn as aforesaid, by the Side of the *Climatory* Parallel to the *Needle* shall be a *North* and *South* Line, or (to speak more properly) a *Meridional* Line.

You may find a *Meridian* Line several other ways; as *First*; If the *Sun* Shine just at Noon, hold up a *Plumb-line* so as the Shadow of it may fall upon your *Plain*; and that Shadow shall be a *Meridian* Line.

*Secondly*, on the Back-side the *Climatory* describe a Circle, and drawn a Line through the Center to both sides the Circumference; Cross this Line with another Line at Right Angles in the Center, so shall the Circle be divided into four equal parts. These four parts you must mark with *East*, *West*, *North*, *South*, and divide each of them into 90 Degrees. In the Center of this *Plain* erect a straight *Wyer* perpendicularly: When you would find a *Meridian* Line, examine by the Tenth Prob. of the Second Book, the *Amplitude* of the *Sun* Rising, or Setting from the *East* or *West* Points, and waiting the just Rising or Setting that Day, turn the Instrument about till the Shadow of the *Wyer* falls upon the same Degree from the *East* or *West* the *Amplitude* is of, for then the *North* and *South* Line in the Instrument will be the same with the *North* and *South* Line in *Heaven*.

*Thirdly*, by the *Sun* *Azimuth*: Find the *Azimuth* of the *Sun* by Prob. 22. of the Second Book: and at the same instant turn the Instrument till the Shadow of the *Wyer* fall upon the Degree on the Instrument opposite to the Degree of the *Sun* *Azimuth*, so shall the *Meridional* Line of the Instrument agree with the *Meridional* Line in *Heaven*.

You may the same way work by the *Azimuth* of any *Star*: Only, whereas the Shadow of the *Wyer* should fall upon the opposite Degree aforesaid: Now you must place a *Sight* or Perpendicular upon that opposite Degree, and turn the Instrument about

bout till the Wyer at the Center, the Sight in the opposite Degree of the Stars Azimuth, and the Star in Heaven, come into one straight Line, so shall the Meridian Line of the Instrument agree with the Meridional Line in Heaven.

Fourthly, It may be found by any Star Observed in the Meridian, if two Perpendiculars be erected in the Meridian Line of your Instrument, for then by turning the Instrument till the two Perpendiculars and the Star come into a straight Line, the Meridian Line of your Instrument will be the same with the Meridian Line in Heaven. See more Waies in Mr. Palmer on the Planisphere; Book 4. Chap. 7.

If your Plain either Recline or Incline, apply one of the Sides of your Clinatory Parallel to one of the Semi-diameters of the Quadrant to the Plain, in such sort that the Plumb-line Hanging at liberty may fall upon the Circumference of the Quadrant, for then the number of Degrees of the Quadrant comprehended between the Side of the Quadrant Parallel to the Plain, and the Plumb-line shall be the number of Degrees of Reclination, if the Center of the Quadrant points Upwards; or Inclination, if the Center points Downwards.

If your Reclining or Inclining Plain Decline, Draw upon it a Line Parallel to the Horizon, which you may do by applying the back side of the Clinatory, and Raising or Depressing the Center of the Quadrant, till the Plumb-line Hang just upon one of the Semi-diameters, for then you may by the Upper side of the Clinatory draw an Horizontal Line if the Plain Incline, or by the Under side if it Recline. If it neither Incline nor Recline, you may draw an Horizontal Line both by the Upper and Under Sides of the Clinatory. Having drawn the Horizontal Line, apply the North side of the Clinatory to it, and if the North end of the Needle points directly towards the Plain, it is then a South Plain. If the North point of the Needle points directly from the Plain, it is a North Plain: but if it points towards the East, it is an East-Plain: if towards the West, a West Plain. If it do not point Directly either East, West, North, or South, then so many Degrees as the Needle Declines from any of those four Points to any of the other of these 4 Points, so many Degrees is the Declination of the Plain, with respect (as aforesaid) had to the Variation of the Compass.

Or if you find the Azimuth of the Sun by its Altitude Observed just when its Beams are coming on or going off your Plain

Plain, that Azimuth shall be the Azimuth of your Plain.

Or you may erect a Wyer Perpendicularly on your Plain, and wait till the Shadow of that Wyer comes to the Perpendicular with the Horizon, which you may examine by applying a Plumb-line to it, for then the Shadow of the Plumb-line and the Shadow of the Perpendicular will be in one: then taking the Altitude of the Sun you may by Prob. 22. of the Second Boord find its Azimuth, and thereby know in what Azimuth the Plain of your Dial lies: for the Azimuth your Plain lies in is distant from the Azimuth of the Sun just 90 Degrees.

### PROB. I.

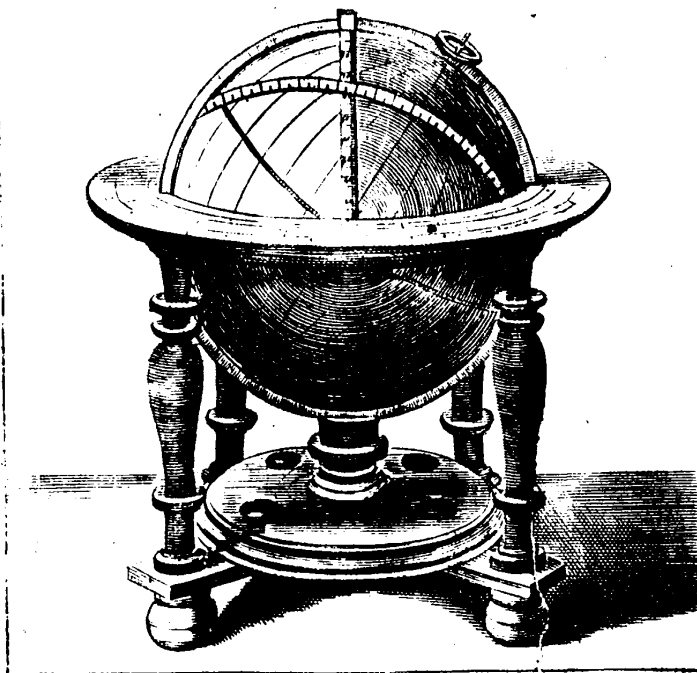
*How by one Position of the Globe to find the Distances of the Hour lines in all manner of Plains.*

YOU may have Meridian Lines drawn from Pole to Pole through every 15 Deg. of the Equinoctial, to represent the Horary Motion of the Sun both Day and Night: and when the Pole of the Globe is Elevated to the Height of the Pole in any Place, and one of these Meridian Lines be brought to the Brazen Meridian, all the rest of the Meridian Lines shall Cut any Circle which you intend shall represent the Plain of a Dial in the number of Degrees on the same Circle that each respective Hour-Line is distant from the Noon-line Point in the same Circle.

Thus if you should enquire the distance of the Hour-lines upon an Horizontal Plain in Londons Latitude; The Pole of the Globe (as aforesaid) must be Elevated  $51\frac{1}{2}$  Degrees, and one of the Meridian Lines (you may chuse the Vernal Colure) be brought to the Brazen Meridian, which being done, you are only to examine in the Horizon (Because it is an Horizontal Plain) at what distance from the Meridian (which in Horizontals is the Noon-line) the several Meridians drawn on the Globe intersect the Horizon, for that distance in Degrees shall be the distance on a Circle divided into 360 Degrees that each respective Hour-line must have from the Meridian, or a Noon-line chosen in the same Circle: and Lines drawn from the Center of that Circle through those Degrees shall be the Hour-lines of an Horizontal Plain.

If it be an Erect Direct South Dial you enquire after; Keep-

ing



ing the *Globe* in its former Position, apply the *Quadrant of Altitude* to the *Zenith*, and its lower end to the *East* Point of the *Horizon*, for then (as was shewed in the *Preface*) by imagining the *Globe* to be prest Flat to the Graduated edge of the *Quadrant of Altitude*, that Flat shall be a *South Plain*, and the number of Degrees the *Meridian* Cuts in the *Quadrant of Altitude* numbred from the *Zenith* Downwards shall be the number of Degrees that each Hour Line shall be distant from the *Meridian* or Noon-line in a Circle of 360 Degrees; and Lines drawn from the Center of that Circle through those Degrees, shall be the Hour Lines of Half the Day: the Hour Lines for the other Half of the Day are of the same distance from the Noon-line, with these; only they must be placed on the other side the Noon-line.

If your *Plain* be not *Direct* but *Declines East* or *West*, you must number the *Declination Eastwards* or *Westwards* respectively in the Degrees of the *Horizon* and (the *Quadrant of Altitude*

*Altitude* screwed to the *Zenith* (as aforesaid) bring the lower end of the *Quadrant of Altitude* to the said Degrees of *Declination*, and the number of Degrees Cut by the *Meridians* in the *Quadrant of Altitude* (numbred Downwards) is the number of Degrees that the Hour-lines are distant from the Noon-Line in a Circle of 360 Degrees: And Lines drawn from the Center of that Circle through those Deg. be the Hour-lines of Half the Day. And if you turn about the *Quadrant of Altitude* upon the *Zenith* Point, till the lower end of it come to the Degree of the *Horizon* opposite to the Degree of *Declination* found before, the *Meridian* Lines on the *Globe* (as before) shall Cut the *Quadrant or Altitude* in the number of Degrees (counted Downward) that each Hour-line is distant from the other side the Noon-line: And Lines drawn from the Center of that Circle through those Degrees shall be the Hour lines of the other Half of the Day.

If your *Plain Decline* and also *Recline* or *Incline*, you must use the *Gnomonical Semi-Circle*, described in Prob. 12. which must be Elevated on the *Quadrant of Altitude* when it is set to the *Declination* (as by the former Rule) according to the Complement of *Reclination*, or *Inclination*. But if your *Plain* be *Direct*, and *Recline*, or *Incline*, it must be set to the *Meridian*, and the *Meridians* on the *Globe* shall Cut that *Semi-Circle* in the number of Degrees counted from the *Quadrant of Altitude*, if the *Plain Declines*, or from the *Brazen Meridian*, if it be *Direct*, that the several Hour-lines are distant from a Line Perpendicular to an *Horizontal* Line in a Circle divided into 360 Degrees: And Lines drawn from the Center through those Degrees shall be the Hour-Lines of such *Reclining* or *Inclining* Plains.

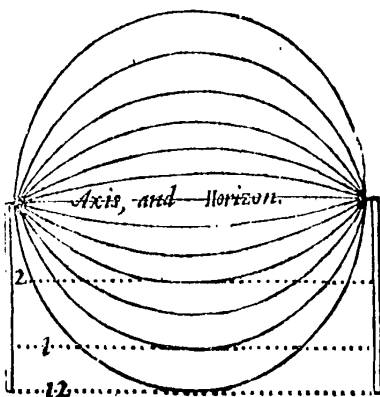
If your *Plain* be an *East* or *West*, either *Direct* or *Declining*; or an *Equinoctial Plain* (for they are upon the matter all one) you may better conceive how they are to be made, than make them by the *Globe*. And for the help of your fancy herein, take Mr. *Blagraves* Conceit, who in his Book 6. Chap. 8. very properly demonstrates the Rules for Projecting the Hour-lines on these Plains. He proposes to take 12 Wyers bowed into exact Circle, all of equal Diameter, and set together at equal distance one from another in two opposite Points, as in two *Poles*, and to have a straight Line to pass from one *Pole* to another, as an *Axis*. These 12 Wyers shall represent 24 *Meridional* Semi-Circles; Or indeed they may represent the *Globe* it self, containing 24. *Meridional*

ridional Semi-Circles to be described on the *Globe*, as aforesaid; And if you place the *Horizon* of the *Globe* *Horizontal*, and the *North* and *South* Points of the *Globe* towards the *North* and *South* Points in *Heaven*, and bring one of these *Wyer Meridians* directly under the *Brazen Meridian* and the *Axis* of this *Wyer-Globe* in the *Plain* of the *Horizon*, and fasten a Thred in the middle of the *Axis* that Thred drawn from the middle of the *Axis* by every one of these *Wyers* shall, if prolonged till it touch an *East* and *West* Line drawn directly Under or Over the Points *Zenith* or *Nadir*, point out on that *East* and *West* Line the distances of each Hour-line from the 12 a Clock Line; and Lines drawn at Right Angles through that *East* and *West* Line, shall be the Hour-lines of an *East* or *West Plain*, or of an *Equinoctial Plain*.

The moving this Thred from *Wyer* to *Wyer* represents the Motion of the *Sun*, which as it passes over all the *Meridians* causes the Shadow of that *Meridional* Semi-circle which it is directly Over, and the *Axis*, and the *Meridional* Semi-circle directly Opposite to the Upper *Meridional* Semi-circle to fall all into one straight Line: and upon what Point in the *East* and *West* Line (mentioned before) that Shadow-line shall fall is marked out by the application of the Thred as aforesaid: and is an Hour-line on any of the aforesaid *Plains*.

If you understand this Problem rightly, you already know how to draw the Hour-lines upon all manner of *Plains*, and need no further Instructions, yet partly fearing a young Student should

not



not clearly understand these Rules, and partly doubting (because other Authors have been more Copious upon this Subject) that I should be censured to be too sparing of my pains, if I should lightly touch so eminent a Doctrine as *Dyalling* is: Therefore I shall more distinctly handle *Dyalling* by the *Globe*, according to the Way or Method that other Authors have Used, and that after so plain a manner as possibly my Genius can devise.

## PROB. II.

## To make an Equinoctial Dial.

Describe a Circle, on a square Board or *Plain*, as BCED and through A the Center thereof draw a straight Line Parallel to one of the Sides, as BE; Cross that straight Line with another straight Line as CD at Right Angles: so shall the Circle be divided into 4 equal parts. Divide each of these four equal parts into 90 Degrees; as in the Figure. This Circle, shall represent the *Horizon*.

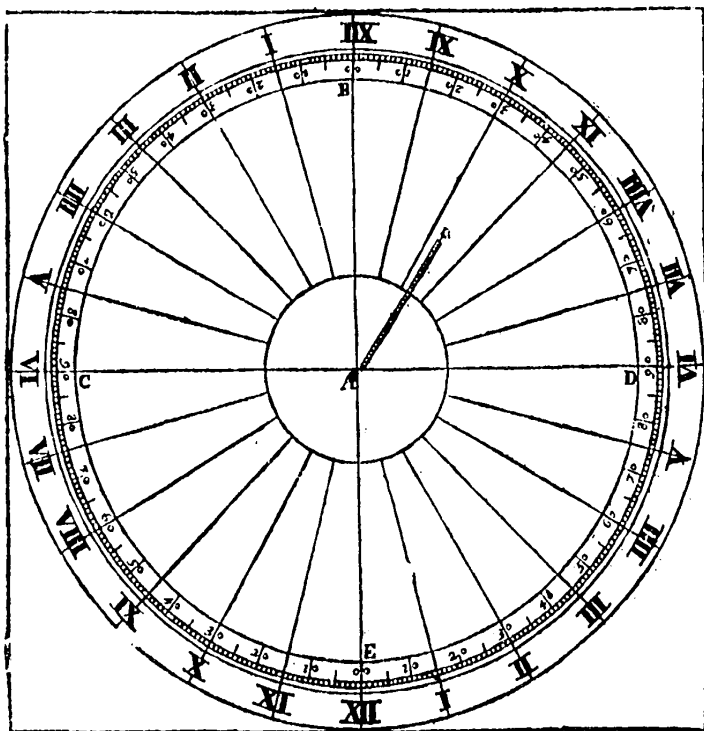
Erect a *Wyer* exactly perpendicular to the Center of the *Plain*, and that *Wyer* shall be the *Gnomon* or *Style* of the *Dial*.

Then Elevate one of the *Poles* of your *Globe* into the *Zenith*, and bring the *Equinoctial Colure* to the *Meridian*. And because in every Hours Time 15 Degrees of the *Equator* passes through the *Meridian* in *Heaven*, therefore turn the *Globe* till 15 Degrees of the *Equator* passes through the *Meridian* of your *Globe*; so shall the *Colure* pass by 15 Degrees of the *Horizon* also. Therefore from the Center of your *Plain* draw straight Lines through 15 Degrees from one of the Semidiameters both waies: and those straight Lines shall be two Hour-lines. Then turn the *Globe* till 15 Degrees more of the *Equator* pass through the *Meridian*, and you will find, as before, the *Colure* pass by 15 Degrees more of the *Horizon*; therefore on your *Plain* number 15 Degrees further beyond both the former Lines, and from the Center draw straight Lines through both those 15 Degrees, and they shall be two Hour Lines more. For all the other Hour Lines turn the *Globe* till 15 Degrees of the *Equator* at a time pass through the *Meridian*; as before, and you will find that for every 15 Degrees of the *Equator* that passes through the *Meridian*, the *Colure* will pass through 15 Degrees of the *Horizon*: therefore those

V 2

Hour

Hour Lines must be drawn from the Center according to the succession of every 15 Degrees on your *Plain*. Having drawn the Hour Lines, you may set Figures on them; beginning to number your Hour Lines from one of the Diameters, marking it with XII, and the next Hour Line to the left Hand with I, and the next II, the next III, &c. to XII: and begin again with I, II, III. &c. till you come to the other XII, where you began: and then your *Dyal* is finished. See the *Figure*.



This is an *Universal Dyal*, and serves in all *Latitudes*: therefore when you place it you must set one of the XII's downwards, and the *Axis* Parallel to the *Axis* of the *World*.

But note, Both *Faces* of this *Dyal* ought to be Divided, and the *Gnomon* must appear on both Sides like the stick in a Whirligig, which Children use; or else you must turn it upside down, to sit as the *Sun* passes the *Equinoctial*.

PROB.

PROB. III.

To make an Horizontal Dyal.

Describe a Circle on your *Plain*, as CBDE, and through the Center A of that Circle draw a *Meridian* (or Twelve a Clock Line) as BE; cross that Line at Right Angles with another Line as CD; so shall your Circle be divided into four equal parts; Divide each of these four parts into 90 Degrees; so shall the whole be divided into 360. These 360 Degrees represent the 360 Degrees of the *Horizon*, which a *Meridian* Line drawn through the place of the *Sun*, runs through in every 24 Hours: The Motion of which *Meridian* Line through the Degrees of the *Horizon* is Regular in a *Parallel Sphere*; for in equal Time it moves an equal Space throughout the whole Circle, viz. it will pass through 15 Degrees of the *Horizon* in one Hours Time (or which is all one) while 15 Degrees of the *Equator* passes through the *Meridian*; as was shewed in the last Problem: But in an *Oblique Sphere* its Motion through the *Horizon* is Irregular, and that more or less according to the more or less *Obliquity* of the *Sphere*: for far Northwards or Southwards you may see this *Meridian* Line pass through 40, 50, yea 60 Degrees of the *Horizon* in one Hours Time, viz. while 15 Degrees of the *Equator* pass through the *Meridian*: but in an other Hours Time you will scarce have 4 or 5 Degrees pass through the *Horizon* while 15 Degrees of the *Equator* pass through the *Meridian*.

But that you may know the Motion of the *Sun* (represented by this *Meridian* Line) through the *Horizon* in all *Latitudes*; Elevate the *Pole* to the *Elevation* of your Place, and chuse instead of a *Meridian* Line through the Place of the *Sun* the *Vernal Colure* to be your *Meridian* Line; both because it is most visible, and because from thence the Degrees of the *Equator* are begun to be numbred, so that whatsoever Decimal Degree of the *Equator* you light on at the *Meridian*, or else where, you will find its number from that *Colure* already set down to your Hand, without either Adding to, or Subtracting from it. Bring this *Colure* therefore to the *Meridian*, and the *Index* of the *Hour Circle* to 12 in the *Hour Circle*. Then turn the *Globe* Westwards



*Westwards*, and so oft as 15 Degrees of the *Equator* passes through the *Meridian*, so oft you must examine what Degree of the *Horizon* the *Vernal Colure* Cuts; and those Degrees and Minutes so Cut by the *Vernal Colure* must be found in the Circle CBDE, beginning your account or reckoning at B towards D, and markt with Pricks: through which Pricks you must draw Lines from the Center A, and those Lines shall be the Hour Lines After-noon. Then bring the *Colure* to the *Meridian* again to find the Forenoon Hour Lines, and turn the *Globe Eastwards*, and so oft as 15 Degrees of the *Equator* passes through the *Meridian*, so oft you must examine what Degrees of the *Horizon* the *Vernal Colure* Cuts; and those Degrees and Minutes so Cut by the *Vernal Colure* must be found in the Circle CBDE, beginning your reckoning from B towards C, and markt with Pricks: through which Pricks you must draw Lines from the Center A, and those Lines shall be the Forenoon Hour Lines.

These Hour Lines must be markt from the *Meridian* Line, viz. the Line AB, which is the 12 a Clock Line towards D, with I, II, III, &c. till you have numbred to the Hour of *Sun* set (found by Prob. 7 of the Second Book) the Longest Day, and from the *Meridian* Line towards C with XI, X, IX, &c. till you have numbred to *Sun* Rising the Longest Day.

The *Style* must be placed in the Center, and Elevated so many Degrees above the *Plain*, as the *Pole* is Elevated above the *Horizon* of the Place.

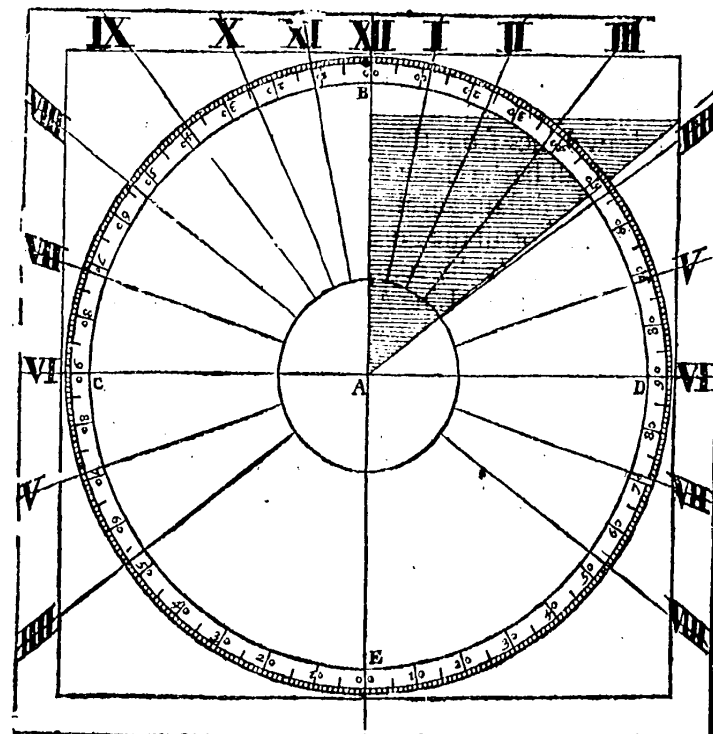
#### Example of the whole.

I would make an *Horizontal Dyal* for *Londons Latitude*: Therefore I elevate the *North Pole*  $51\frac{1}{2}$  Degrees above the *Horizon*, and bring the *Vernal Colure* to the *Meridian*, and the *Index* of the *Hour-circle* to 12 on the *Hour-circle*.

And turning  $\left\{ \begin{array}{l} 1 \text{ a Clock, or till } 15 \\ 2 \left\{ \begin{array}{l} \text{Deg. of the Equator pass through} \\ \text{the Meridian; I} \end{array} \right. \\ 3 \left\{ \begin{array}{l} \text{find the Colure} \\ \text{Cut the Horiz. in} \end{array} \right. \end{array} \right. \left. \begin{array}{l} 11.40 \\ 24.15 \\ 38.4 \\ 53.36 \\ 71.6 \\ 90. \end{array} \right\} \text{ from the Meridian.}$

These are the distances of the Hour Lines from Noon till 6 at Night; and to these distances on the *Plain* (counting from B towards

wards D,) I make Pricks and from the Center I draw Lines through these Pricks; and these Lines are the Hour-lines from 12 to 6 Afternoon. But the *Sun* in the Longest Day shines till past 8 at Night, as you may find by Prob. 48. of the Second Book; therefore here wants the two Evening Hour-lines; which though they may be found after the same way I found the former (viz. by continuing the turning the *Globe Westwards*) yet that I may the sooner reduce my Work to the *Plain*, I count the number of Degrees between the 7 a Clock Line and the 5 a Clock Line in the circle on the *Plain*; for the same number of Deg. counted from D towards E is the distance of the 7 a Clock Hour-line from the 6 a Clock hour-line; and the number of Deg. contained between the 6 a Clock hour-line and the 4 a Clock hour-line is the distance of the 8 a Clock hour-line from the 6 a Clock-Hour-Line.



Or I need not draw the 7 and 8 a Clock Hour Lines, till I have drawn the Fore-noon Hour-lines: for then by laying the

the edge of a Ruler (that will reach through the opposite side of the *Plain*) to the Morning 7 and 8 a Clock Hour Lines, I may by the side of that Ruler draw Lines from the Center through the opposite side of the *Plain*, and those Lines shall be the 7 and 8 a Clock Hour Lines Afternoon.

Having thus all the Afternoon Hour Lines, I bring the *Vernal Colure* to the *Meridian* again; so shall the *Index* again point to 12. Therefore as before I turned the *Globe Westwards*, so now

turning it	11	a Clock, or till 15	11.40	} from the <i>Merid.</i>
<i>Eastwards</i> ,	10	deg. of the <i>Equator</i>	24.15	
till the <i>Index</i>	9	pass through the <i>Me-</i>	38.4	
points	8	<i>ridian</i> , I find the	53.36	
to	7	<i>Colure</i> Cut the <i>Ho-</i>	71.6	
	6	<i>rizon</i> in	90.	

These are the distances of the Hour Lines from Noon to 6 a Clock in the Morning; and these distances, I seek in the Circle of the *Plain* (counting from the Noon Line B towards C) and mark them with Pricks; through which Pricks (as before) I draw Lines from the Center to the outside *Plain*; and those Lines shall be the Hour Lines.

Or, having the distance of all the Afternoon Hour Lines, I have also the distance of all the Forenoon Hour Lines from the *Meridian*; as you may see by comparing the two former Tables: For the 1 a clock Hour Line Afternoon is equidistant from the *Merid.* or Noon Line with the 11 a Clock Hour Line before Noon, *viz.* they are both 11 Deg. 40 Minutes distant from the Noon Line, and the 2 a Clock Hour Line After-noon is from the Noon Line equidistant with the 10 a Clock Hour Line Before-noon; for they are both 24 Deg. 15 Minutes distant from the *Merid.* or Noon Line: and so all the other Morning Hour Lines are distant from the Noon Lines by the same space that the same number of Afternoon Hour Lines (told from the *Meridian* on the contrary side the Noon Line) are distant from *Meridian*.

Whence it follows, that since (as aforesaid) the same number of Hour Lines after 6 at Night, and before 6 in the Morning have the same distance from the 6 a Clock Line that the same number of Hour Lines before 6 at Night and after 6 in the Morning have from the 6 a Clock Line; and since the same number of Hour Lines

Lines Before Noon are equidistant from the *Meridian* or Noon Line by the same space of Degrees that the same number of Hour Lines Afternoon are, It follows (Ifay) that having found the distance of the Six Hour Lines either before or after Noon, you have also given the distance of all the other hour lines.

If you will have the Half Hour Lines placed on your *Dyal*, you must turn the *Globe* till the *Index* points to every half Hour in the *Hour-Circle*, as well as to the whole; and examine the Degrees of the *Horizon* Cut by the *Vernal Colure*, as you did for the Whole Hours; and in like manner transfer them to your *Plain*.

Having thus drawn all the Hour Lines, I count from the Noon Line  $51\frac{1}{2}$  Degrees, the Elevation of the *Pole* here at *London*; and from the Center A, I draw a straight Line, as A F through these  $51\frac{1}{2}$  Degrees for the *Gnomon* or *Style*, and prolong it to the farthest extent of the *Plain*: From this *Gnomon* or *Style* I let fall a Perpendicular upon the Noon Line as F G (this Perpendicular is called the *Substyle*) and this Perpendicular and its Base (which is the Noon Line) and Hypotenuse (which is the *Gnomon*) shall make a Triangle, which being erected upon the Base, so as the *Substyle* may stand Perpendicular to the *Plain*, the Hypotenuse A F shall be the *Gnomon*, and be parallel to the *Axis* of the *World*; and cast a shadow upon the Hour of the Day.

#### PROB. IV.

To make an Erect direct South Dyal.

**D**RAW on your *Plain* an *Horizontal* Line as C A D, as was shewed in the *Preface*: in the middle of this Line (as at A) describe as on a Center the Semi-Circle CBD: from the Center A let fall a Perpendicular, which shall divide the Semi-Circle into two *Quadrants*, each of which *Quadrants* you must divide into 90 Degrees. Then Rectifie the *Globe*, *Quadrant* of *Altitude*, *Colure* and *Hour Index*, thus, Elevate the *Pole* of the *Globe* to the *Latitude* of your Place, and screw the *Quadrant* of *Altitude* to the *Zenith*. Then bring the *Vernal Colure* to the *Meridian*, and the *Index* of the *Hour-Circle*, to the Hour of 12 in the *Hour-Circle*, so shall your *Globe*, *Quadrant* of *Altitude*, *Colure*, and *Hour Index* be Rectified. And thus you must alwaies Rectifie them for the making of most Sorts of *Dyals* by the

Globe. Then to make an *Erect Direct South Dial*, Bring the lower end of the *Quadrant of Altitude* to the *West Point* of the *Horizon*; and turn the *Globe Westwards* till the *Index* points to all the Hours Afternoon; and examine in what numbers of Degrees from the *Zenith* the *Colure* Cuts the *Quadrant of Altitude* when the *Index* Points to each Hour: for a Line drawn from the Center A through the same number of Degrees reckoned from the Perpendicular A B (which is the 12 a Clock Line) towards D on the *Plain*, shall be the same Hour-Lines the *Index* points at.

Thus in our *Latitude*, viz.  $51\frac{1}{2}$  Degrees the *Vernal Colure* being brought to the *Meridian* and the *Index* to 12,

If you turn the	1	a Clock, or till 15	9.18	} counted from the Zenith.
Globe West-	2	Deg. of the Equa-	19.15	
wards, till the	3	tor pass through	32. 5	
Index points	4	the Meridian, the	48. 0	
to	5	Colure will Cut	67. 4	
	6	the Quad. of Alt. in	90.	

And these are the distances of the after-noon Hour-lines; which you must transfer to the *East side* of your *Plain*, viz. from B towards D; and draw Lines from the Center A through these distances; and these Lines shall be your After Noon Hour-Lines.

Note (once for all) when the *Colure* goes off that Circle you examine the Hour distances in, the *Sun* will Shine no longer upon that Plain; as in this example, the *Colure* goes off the *Quadrant of Altitude* at 6 a Clock, therefore the *Sun* will not Shine longer than till 6 a Clock upon this Plain.

The Hour-Lines Before Noon have the same distance from the *Meridian* that the After Noon Hour Lines have, as was shewed in the last Probleme: Only they must be counted from B towards C, and drawn on the *West side* the Noon Line.

### Otherwise.

You may reduce all *Verticals* into *Horizontals*; if you Elevate the *Pole* of the *Globe* to the *Complement* of the *Latitude* of your Place, and bring the *Vernal Colure* to the *Meridian* under the *Horizon*, and the *Index* of the *Hour Circle* to 12; and turn the

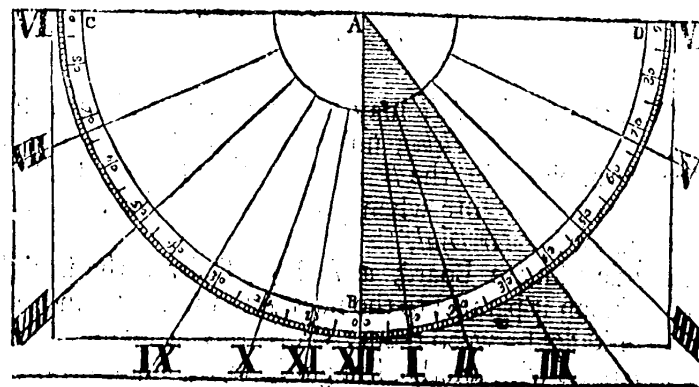
the *Globe Westwards*, for as the *Index* passes through every Hour on the *Hour Circle*, the *Colure* shews in the *Horizon* the distance of the several Afternoon Hour Lines from the *Meridian* or 12 a Clock Line, in the *Circle* on your *Plain*, numbred from B to D: and Lines drawn from the Center through these distances on your *Plain* shall be the After Noon Hour Lines of your *Dial*.

### Example.

*Londons Latitude* is  $51\frac{1}{2}$  Degrees, Its *Complement* to 90 is  $38\frac{1}{2}$ . Therefore I Elevate the *Pole*  $38\frac{1}{2}$  Degrees above the *Horizon*, and bring the *Vernal Colure* to the *Meridian* under the *Horizon*, and the *Index* of the *Hour circle* to 12 on the *Hour Circle*. Then

Turning	1	a Clock, or till 15	9.18	} from the inter- section of the Meridian and the Horizon, as in the former Table.
the Globe	2	Deg. of the Equa-	19.15	
Westwards,	3	tor pass through	32. 5	
till the In-	4	the Meridian; I	48. 0	
dex points	5	find the Colure Cut	67. 0	
to	6	the Horizon in	90.	

And these are the distances of the 6 Hour Lines from the *Meridian*; As you may see in this Figure.



By this Example you may see it is easy to reduce *Verticals* into *Horizontals*; and *Horizontals* into *Verticals*: for this *Erect Direct South Dial* is an *Horizontal Dial* to those People that Inhabite 90 Deg. from Us, viz. in the *South Latitude* of  $38\frac{1}{2}$  Degrees. Then make a Triangle, whereof the Noon Line shall be

X 2

Ba

Base: from it count the *Complement* of the *Poles Elevation*, viz.  $38\frac{1}{2}$  Degrees, and through them draw the Line A F, from the center A which shall be the Hypothenufa; Then let fall a Perpendicular upon the Noon Line A B, so is your Triangle made. If this Triangle be erected perpendicularly upon the Base or Noon Line, the Hypothenufa A F shall stand parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

## P R O B. V.

To make an Erect Direct North Dyal.

If the *Erect Direct South Dyal* were turned towards the North, and the Line C A D were turned Downwards, and the Line marked with 7 be now marked with 5, and the Line 8 with 4, and the Line 5 with 7, and the Line 4 with 8, then have you of it a *North Erect Direct Dyal*.

All the other Hour Lines in this *Dyal* are Useless, Because the *Sun* in our Latitude Shines on a *North Face* the longest Day only before 6 in the Morning, and after 6 at Night.

## P R O B. VI.

To make an Erect Direct East Dyal.

These Sorts of *Dyals* may better be demonstrated than made by the *Globe*; unless the *Axis* of your *Globe* were accessible, as in the *Wyer-Globe*, specified in Prob. 1. Of this Book therefore when you would make an *East* or *West Dyal*, or a *Polar Dyal*,

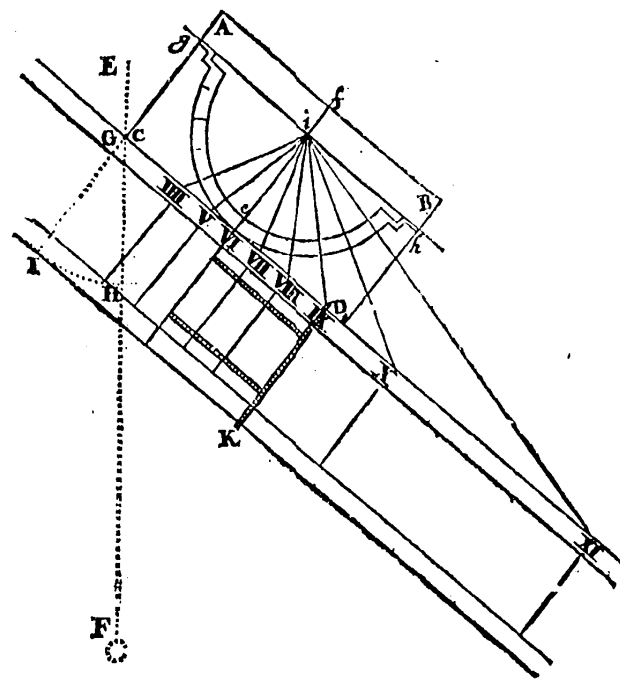
Provide a square Board; as A B C D, draw the straight Line *e f* upon it parallel to the sides A C, and B D, and just in the middle between them: Cross this straight Line at Right Angles with another straight Line, as *g h*, quite through the Board:

Upon this Board with a little Pitch or Wax fasten the *Semi-Circle of Position*, so as both the *Poles* thereof may lie in the Line *g h*, and the middle of the *Semi-Circle* marked *oo* may lie upon the line *e f* so shall *i* be the Center of the *Semi-circle of Position*; In

In this Center make a small Hole through the Board fit to receive a *Wyer* or a *Nail*: So may you with the *Circle of Position* thus fitted, and the side C D applied to a Line of Contingence Elevated to the Height of the *Equinoctial*, draw Lines from the Center through every 15 Degrees of the *Circle of Position*, and by continuing them intersect the Line of Contingence in the points from whence the Hour Lines of an *East* or *West Dyal* is to be drawn.

## Example.

I would make an *Erect Direct East Dyal* for *Londons Latitude*. Therefore I fasten a *Plumb-line* a little above the place



on the Wall where I intend to make my *Dyal*, and wait till it Hangs quietly before the Wall: then if the line be rubbed with Chalk (like a *Carpenters line*) I may by holding the *Plumber* end close to the Wall, and straining it pretty stiff, strike with it a straight

straight line as *Carpenters* do. This line shall be a Perpendicular as E F: I chuse a convenient point in this Perpendicular, as at G, for a Center: whereon I describe an occult Arch as H I; this Arch must contain the number of Degrees of the Elevation of the *Equinoctial* counted between H and I (which in our *Latitude* is 38 $\frac{1}{2}$ ) Therefore in a *Quadrant* of the same *Radius* with the occult Arch I measure 38 $\frac{1}{2}$  Degrees, and set them off in the *Plain* from H in the Perpendicular to I: Then from I to the Center G in the Perpendicular, I draw the Prick line I G, and this Line shall represent the *Axis* of the *World*: I cross this *Axis* at Right Angles with the Line G K, and draw it from G to K, so long as I possibly can: this Line shall be the *Contingent line*. I find a convenient place in this *Contingent-line*, as at V I, to which I apply the side of the Board C e D so as that the point e may ly just upon V I in the *Contingent-line*; and having a Thred fastened in the Center of the *Semi-Circle of Position*, I draw that Thred straight over the first 15 Deg. of the *Circle of position*, numbred from o towards b, and where the Thred Cuts the *Contingent-line* I make a Mark, for that Mark shall be the Mark for the 7 a Clock Line. From thence I remove the Thred to 30 Degrees of the *Semi-Circle* and draw it through the *Contingent-line*, and where it Cuts the *Contingent-Line* there shall be the Mark for the 8 a clock Line. From thence I remove the Thred to 45 Degrees of the *Semi-Circle* and draw it through the *Contingent-line*, and where it Cuts the *Contingent line* there shall be the Mark for the 9 a Clock Line. From thence in like manner I remove the Thred to 60 and 75, and where the Thred Cuts the *Contingent-line* shall be the Mark for 10 and 11 Clock Lines; The 12 a Clock Line cannot be drawn on this *Plain*, as you may see, if you apply the Thred to 90 Degrees, for though you should draw it out never so far, yet would it never touch the *Contingent-line*, because it is Parallel to the Line g b, and lines Parallel never meet.

But because in our *Latitude* the *Sun* Rises before 4 in the Morning, therefore two Hour Lines are yet wanting, viz. 5 and 4, which I may find either by applying the Thred first to 15, and next to 30 Degrees from o towards g in the *Semi-Circle*, and so Marking where it Cuts the *Contingent-line*, as before: Or else by transferring the distance of the same number of Hour Lines from the 6 a Clock Line already drawn on the side e b, to the side e g, as in Prob. 2. of this Book is more fully shewed.

Having

Having thus Marked out on the *Contingent-line* the distances of each Hour; I draw a Line parallel to the *Contingent-line*, and draw Lines from every Hour Mark on the *Contingent* to cross the *Contingent-line* at Right Angles, and continue each Line to the Line parallel to the *Contingent*; and these Lines shall be the Hour Lines of an *East Plain*. To these Hour Lines I set figures, as in the *Scheme* may be seen.

The *Style* D K of this *Dyal* (as well as of others) must stand parallel to the *Axis* of the *World*: It must be also parallel to all the Hour Lines, and stand directly over the 6 a Clock Line, and that so high as in the distance between the Center of the *Semi-Circle of Position* and the point where the 6 a Clock Line Cuts the *Contingent-line*: Or (which is all one) at such an Height as when it is laid Flat down upon the *Plain* it may just reach the 9 a Clock Line.

### PROB. VII.

To make an Erect Direct West Dyal.

**A**N Erect Direct West Dyal is the same in all respects with an Erect Direct East Dyal; Only as the *East* shews the Fore-noon Hours, the *West* shews the Afternoon-Hours.

Thus if you should draw the *East Dyal* on any transparent *Plain*, as on Glasse, Horn, or an oyled Paper, on the one Side will appear an *East Dyal*, and on the other a *West*; Only the Figures (as was said before) must be changed; for that which in the *East Dyal* is 11, in the *West* must be 1: that which in the *East Dyal* is 10, in the *West* must be 2: that which in the *East Dyal* is 9, in the *West* must be 3. &c.

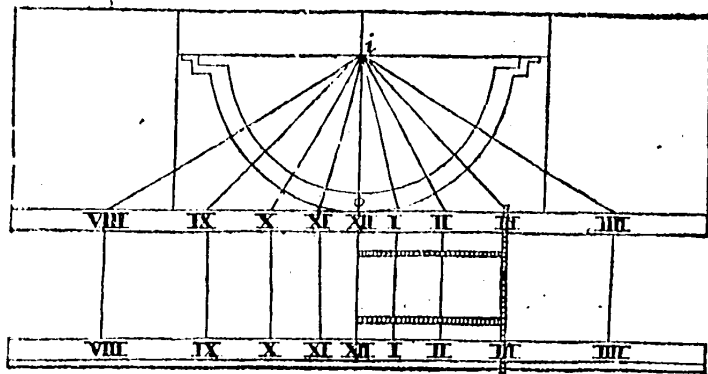
### [PROB. VIII.]

To mark a Polar Dyal.

**P**olar Dyals are Horizontal Dyals under the *Equinoctial*: They are of the same kind with *East* and *West Dyals*; Only whereas *East* and *West Dyals* have but the Hour Lines of Half the Longest Day described on them, these have all the Hour Lines

Lines of the whole Day; and are marked on both Sides the Noon line; as in the following Figure.

The *Style* of this *Dyal* must stand over the Noon Line, Parallel to the Plain; for then it will also be parallel to the *Axis*.



of the *World*; and its Highth above the *Plain* must be the distance between the Center of the Semi-Circle and the point in the *Contingent-Line* Cut by the Noon-line. But I have inserted the *Figure*, which alone is sufficient instructions.

### PROB. IX.

To make Erect South Dyals, Declining Eastwards or Westwards.

**D**RAW on your *Plain* an *Horizontal-line*, and on it describe a Semi-circle, as you were taught in Prob. 4.

Then Rectifie the *Globe*, *Quadrant of Altitude*, *Colure*, and *Hour-Index*, as by the same Probleme; and bring the lower end of the *Quadrant of Altitude* to the Deg. of Declination from the North point in the *Horizon* Eastwards or Westwards; for then the *Quadrant of Altitude* shall represent a *Plain Declining* from the North Eastwards, or Westwards accordingly. Then turn the *Globe Eastwards*, till the *Index* of the *Hour-circle* points to all the Hours before Noon, and examine in what number of Degrees from the *Zenith* the *Colure* Cuts the *Quadrant of Altitude*, when the *Index* points to each Hour, For a Line drawn from the Center A through the same number

ber of Degrees reckoned from the Perpendicular A B, which is the 12 a Clock Line towards C on the *Plain*, shall be the same Hour-lines the *Index* points at.

### Example.

I would make an *Erect Dyal Declining* from the North towards the East 63 Degrees: The *Globe*, *Quadrant of Altitude*, *Vernal Colure*, and *Hour-Index* Rectified, as before I bring the lower end of the *Quadrant of Altitude* to 63 Degrees counted from the North point of the *Horizon* towards the East: Then

I turn the	11	a Clock: or till 15	9.43	} counted from the Zenith.
Globe East-	10	Deg. of the Equa-	19. 0	
wards till	9	tor pass through	25.57	
the Index	8	the Meridian, and	35.10	
points to	7	find the Colure	45.56	
	6	Cut the Quadrant	60.15	
	5	of Altitude in	79.45	

And these are the distances of the Fore-noon Hour-lines, which I seek in the *VWest-side* of the *Plain*, viz. from B towards C; and through these distances I draw lines from the Center, and these Lines shall be the Fore-noon Hour-lines.

Now herein is a difference between *Declining Dyals*, and *Direct Dyals*; For having found the distances of the Hour-lines for one Half of the Day, be it either for Before Noon or After Noon in a *Direct Dyal*, you have also found the distances for the other Half Day; because, as was said Prob. 3. Equal number of Hours have equal distance from the Noon line: But in *Declining Dyals* it is not so: Because the *Sun* remaining longer upon that side of the *Plain* which it *Declines* to, than it doth upon the contrary Side, there will be a greater number of Hour Lines upon it, and by consequence the distance of the Hour lines less than on the contrary Side of the *Plain*.

Therefore for finding the After Noon Hour lines, I turn about the *Quadrant of Altitude* upon the *Zenith* point till the lower end of it come to the Degree of the *Horizon* opposite to that Deg. of Declination that the *Quadrant of Altitude* was placed at when I sought the Fore Noon Hour Lines, viz. to 63 Degrees counted

counted from the *South* toward the *West*, and bring the *Vernal Colure* again to the *Meridian*, and the *Index* (as before) to 12. Then,

turning the *Globe*  $\left\{ \begin{array}{l} 1 \text{ a Clock, or till } 15 \text{ Deg. of the} \\ \text{Westwards till } \left\{ \begin{array}{l} 1 \text{ Equinox pass through the Me-} \\ 2 \text{ rid. I find the Colure Cut} \\ 3 \text{ the Quadrant of Altitude in } \end{array} \right. \end{array} \right. \left. \begin{array}{l} 11.20 \\ 26.47 \\ 49.20 \\ 75.51 \end{array} \right\} \text{ counted from the Zenith.}$

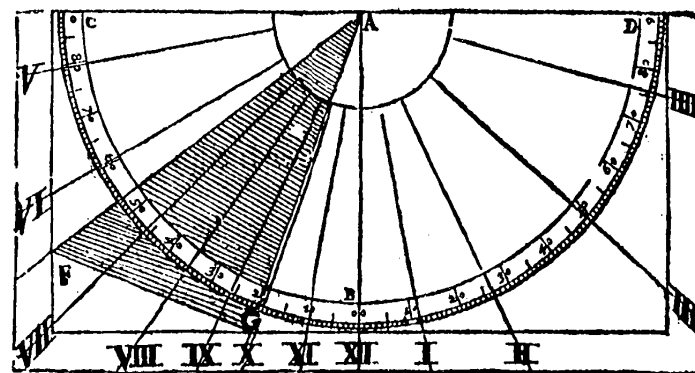
And these are the distances of the After Noon Hour Lines, which distances I seek in the *East Side* of the *Plain*, viz. from B towards D (as before) and so drawing Lines from the Center A through these distances, I have all the Afternoon Hour Lines also drawn on my *Plain*.

You may note, that this *Plain* is capable to receive no more Hour Lines After Noon than 4; for when the *Colure* goes off the *Quadrant of Altitude*, the Sun goes off these kind of *Plains*.

To these Hour Lines I set their numbers, as you may see in the *Figure*.

Then to find both the distances of the *Substyle* line from the 12 a Clock line, and the Elevation of the *Style* above the *Plain*, Bring the *Colure* to the number of Degrees of the *Plains Declination*, counted in the *Horizon* from the *South* point to the *East* point, and the *Quadrant of Altitude* to the Degrees of the *Plains Declination*, counted in the *Horizon* from the *North* point towards the *East*, so shall the *Quadrant of Altitude* and the *Colure*, Cut each other at Right Angles; and the number of Degrees comprehended between the *Colure* and the *Zenith* in the *Quadrant of Altitude*, shall be the number of Degrees between the *Substyle* line and the 12 a Clock Line, which in this *Example* is 19 Degrees 45 Min. and the number of Degrees comprehended between the *Quadrant of Altitude* and the *Pole*, counted in the *Colure*, shall be the number of Degrees that the *Style* is to be Elevated above the *Plain*; which in this *Example* is 33 Degrees 40 Min. Wherefore for the distance of the *Substyle* line from the 12 a Clock Line, I count in the Circle from the 12 a Clock line in the contrary side of the *Plain*, viz. in the *West* side (because the *Plain Declines* towards the *East*) 19 Deg. 45 Min. as at D, and through that number of Degrees and Min. from the Center A, I draw the line A G, which shall be the *Substyle* line: And from the *Substyle* Line (either way) I number 33 Degrees 40 Min. the Elevation of the *Style* above the *Plain*, and through

through these Degrees and Minutes I draw from the Center A, the line A F, for the *Style* or *Gnomon*; Then I let fall the Perpendicular F G upon the *Substyle* A G: So is there a Triangle



made, which if it be erected Perpendicular upon the *Substyle* A G, the *Style* A F shall be Parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

Here you may see that in *Declining Dyals* the *Style* doth not stand at the same Elevation above the *Plain*, that it doth in *Erect Direct Dyals*; neither doth it stand over the 12 a Clock Line; but swerves from it towards the Quarter of *Declination*.

### PROB. X.

To make a South Erect Dial, Declining Eastwards or Westwards.

AS in Prob. 5. an *Erect Direct North Dial* hath the same Declination that an *Erect Direct South Dial* hath, and differs only in the placing the *Figures* of the Hour Lines: So a *South Erect Dial* that *Declines Eastwards*, or *Westwards*, differs from a *North Erect Dial* that *Declines Eastwards* or *Westwards*, the same number of Degrees, only in placing the Hour lines at the same distance on the contrary Side of the *Plain*, and by transposing the *Figures* of 11 for 1: 10 for 2: 9 for 3. &c.

Thus, if you draw upon Glass, Horn, or an Oyled Paper, the *North Dial Declining Eastwards*, as in the foregoing Probleme,



and place it to its due Situation, the back Side of it shall be a *South Dyal Declining* towards the *West* so many Degrees as the foresaide *Declines* towards the *East*; and the only difference in it will be the *Figures* of the Hour lines; as was said before.

## PROB. XI.

To make Direct Reclining, or Inclining Dyals.

**D**irect Reclining or Inclining Dyals are the same with Erect Direct Dyals that are made for the Latitude of some other Places: The Latitude of which Places are either More than the Latitude of your Place, if the Plain Recline, or less if the Plain Incline; and that in such a Proportion as the Arch of Reclination or Inclination of your Plain is.

Thus a Direct South Dyal Reclining 10 Degrees in London's Latitude, viz.  $51\frac{1}{2}$  Degrees is an Erect Direct Dyal made for the Latitude of  $61\frac{1}{2}$  Degrees: And a Direct South Dyal Inclining 10 Degrees in the Latitude  $51\frac{1}{2}$  Degrees is an Erect Direct Dyal in the Latitude  $41\frac{1}{2}$  Degrees; and is to be made according to the Directions in Prob. 4.

## PROB. XII.

To make Declining Reclining or Declining Inclining Dyals.

**T**he distances of the Hour Lines either for a Declining Reclining Plain, or a Declining Inclining Plain, may most easily be found upon the Plain of the Horizon. That is (as some Authors call it) by the Horizontal Dyal, by changing the Circles of the Globe one into another: So as the Plain of the Horizon may serve to represent the Dyal Plain; Yet this way not being Natural, because you must admit one Circle to be another, and that in Young Learners might sometimes breed a little difficulty, Gemma Frisius, Metius, and Blaeu have prescribed a Thin Brass Plate to be made equal to a Semi-Circle of the Equinoctial, and divided from the middle point of it either way into 90 Degrees, which may not improperly be called a *Gnomonica* Semi-Circle. This Semi-Circle must be

bowled

bowled close to the Body of the Globe into a Semi-Circular Form, and so set to any Reclination or Inclination, and then it will represent a Reclining or Inclining Plain: And by the motion of the Colure through the several Degrees of this Semi-Circle the distances of the Hour lines may be found: Thus,

The Globe Quadrant of Altitude, Colure, and Hour Index Rectified; as by Prob. 4. Bring the lower end of the Quadrant of Altitude to the Degree in the Horizon of the Plains Declination, if your Plain be a South Declining Incliner, or a North Declining Recliner, and count on the Quadrant of Altitude from the Zenith Downwards the number of Degrees of Reclination, or Inclination, and to that number of Deg. bring the middle of the Gnomonical-Semi-circle, and let the ends of it cut the Horizon on either side in the Degrees of the Plains Azimuth, so shall the Gnomonical-Semicircle represent your Reclining or Inclining Plain. And so oft as 15 Degrees of the Equator passes through the Meridian, so oft shall you enquire what Deg. of the Gnomonical Semi-Circle the Colure cuts; for so many Degrees as under must the several respective Hour Lines of a Reclining Declining Plain be in a Semi-Circle divided into 180 Degrees.

But if your Plain be a South Declining Recliner, or a North Declining Incliner; Bring the Quadrant of Altitude to the Deg. of the Horizon opposite to the Degree of the Plains Declination (because the Upper side of the Plain lies beyond the Zenith) counted from the South point in the South Recliners; and from the North point in North Incliners.

Then find the Height of the Style, and place of the Substyle: thus, Keep your Gnomonical Semi-Circle in its Position: But turn the Quadrant of Altitude about on the Zenith Point till the Lower end of it comes to the Deg. of the Horizon opposite to the Deg. it was placed at before, and turn about the Globe till the Colure cut the Quadrant of Altitude above the Horizon in the number of Degrees the Plain Reclines from the Zenith; so shall the Colure cut the Gnomonical Semi-Circle at Right Angles; then count the Degrees contained between the middle of the Gnomonical Semi-Circle and the Colure, for that number of Deg. is the distance of the Substyle from a Perpendicular Line in the middle of your Plain, and must be placed Westwards of the said Perpendicular, if your Plain decline from the South Eastwards; or Eastwards, if your Plain decline from the South Westwards

wards. Then Observe how many Degrees are contained between the Semi-Circle and the Pole; for that number of Degrees is the number of Degrees that the Style is to be Elevated above the Substyle.

### Example.

Here at *London*, I would make a *Dial* upon a *Plain Declining* from the *South Eastwards* 30 Degrees, and *Reclining* from the *Zenith* 20 Degrees; *London's Latitude* is  $51\frac{1}{2}$  Degrees: Therefore, having on the *Plain* described a *Semi-Circle*, &c. as was directed *Prob. 4.* I Rectify the *Globe*, *Quadrant of Altitude*, *Colure* and *Hour Index*, as by the same Probleme, and bring the lower end of the *Quadrant of Altitude* to 30 Degrees from the *North Point* of the *Horizon* towards the *West*, because that is the Deg. opposite to the Degree of the *Plains Declination*, viz. to 30 Degrees from the *South Eastwards*, and I bring the middle of the *Gnomonical Semi-Circle* to 20 Degrees of the *Quadrant of altitude* counted from the *Zenith* downwards towards the *Horizon*, and the ends of the *Gnomonical Semi-Circle*, to the Degrees of *Azimuth* the *Plain* lies in the *Horizon*, viz. to 30 Degrees from the *East Point Northwards*, and to 30 Degrees from the *West Point Southwards*, so shall 11 Degrees 10 Minutes of the *Gnomonical Semi-Circle* be comprehended between the *Quadrant of Altitude* and the *Brass Meridian*: These 11 Degrees 10 Minutes shew that the 12 a Clock Line is distant from the Perpendicular *A B* 11 Degrees 10 Minutes: Then to find all the *Fore-Noon Hour Lines*,

I turn the Globe East- wards till the Index points to	{	11	a Clock: or till 15	15. 8	{	counted from the middle of the <i>Gnomonical</i> <i>Semi-Circle</i> .
		10	Deg. of the Equa-	18. 56		
		9	tor pass through	22. 37		
		8	the Meridian; and	26. 52		
		7	find the Colure	32. 37		
		6	cut the <i>Gnomonical</i>	42. 5		
		5	<i>Semi-Circle</i> in	62. 43		

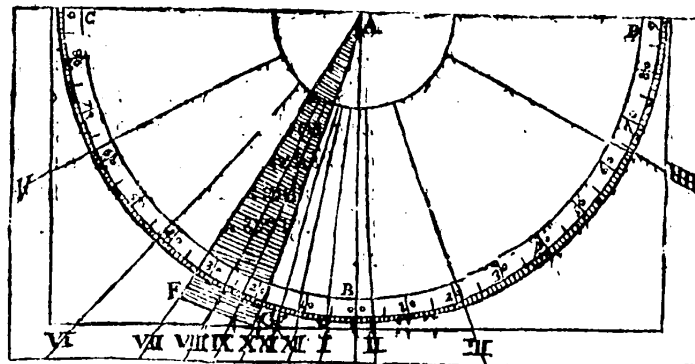
And these are the distances of the *Fore-Noon Hour lines*; to which distances you may set Pricks on the *West* side the *Semi-Circle* of the *Plain*, viz. from *B* to *C*.

The

The after Noon Hour Lines are found by bringing the *Colure* again to the *Meridian*, and the Index of the *Hour Circle* to 12. For then

turning the Globe West- wards till the Index points to	{	1	a Clock, or till 5 Deg. of the	19. 45	{	counted from the middle of the <i>Gnomon</i> <i>Semi-Circle</i> .
		2	Equator pass through the	22. 54		
		3	Meridian, I find the Colure	26. 52		
		4	Cut the <i>Gnomon. Semi-Cir.</i>	64. 36		

And these are the distances of the after-noon Hour lines; and must all but the 1 a Clock Hour-line be prickt down at their respective distances on the East side the *Plain*, viz. from *B* to *D*: But because the *Colure* comes not to the middle of the *Gnomonical Semi-Circle* before the first 15 Degrees of the *Equator* pass through the *Merid.* after 12. Therefore the 1 a Clock must stand 5 Degrees 45 Minutes on the *West* side of the *Plain*: And for this cause I made distinction with a line between the 1 a Clock.



and the 2 a Clock, in the foregoing Table. Then I draw Lines from the Center *A* through every one of these Pricks in the *Semi-circle*, and they shall be the *Hour Lines* of this *Declining Reclining Plain*.

Having drawn the *Hour Lines*, I remove the *Quadrant of Altitude* to the Degree of the *Horizon* opposite to the Deg. it was at before, viz. to 30 Degrees from the *South Eastwards*, which is so much as the *Plain Declines Eastwards*. But I let the *Gnomonical Semi-Circle* stand as it did: And turning about the *Globe*

Globe till the Colure Cut the Quadrant of Altitude in 20 Degrees counted from the Horizon Upwards; viz. the Degrees of Reclination, I find 18 Degrees 40 Min. contained between the middle of the Gnomonical Semi-Circle and the Brazen Meridian, which is the distance of the Substyle from the Perpendicular; And I find the Gnomonical Semi-Circle Cut the Colure in 13 Degrees 49 Minutes from the Pole, which is the Height that the Style must be Raised over the Substyle; Therefore I Prick off in the Semi-Circle on the Plain, the distance of the Substyle 18 Degrees 49 Minutes from the Perpendicular Westward, because this Plain Declines Eastwards: And from the Center A, I draw through that Prick the Line A E, which shall be the Substyle, and from this Substyle (either way) I count in the Semi-Circle on the Plain 13 Degrees 49 Minutes, and there make a Prick: Then from the Center A, I draw through that Prick the Line A F, to represent the Style or Gnomon: Then I let fall the Perpendicular F G upon the Substyle A G; so is a Triangle made, which if it be erected Perpendicularly upon the Substyle A G, the Style A F shall be Parallel to the Axis of the World, and cast a Shadow upon the Hour of the Day.

Having made this Dyal, you have made four several Dyals, whereof this is one: And his opposite, viz. North Declining Westwards 30 Degrees Inclining to the Horizon 70 Degrees is another. The South Declining Westwards 30 Degrees Reclining from the Zenith 20 Degrees is another: And his opposite, viz. North Declining Eastwards 30 Degrees Inclining to the Horizon 70 Degrees is the other.

## P R O B. XIII.

## To make a Dyal upon a Declining Inclining Plain.

The Precepts for making these Dyals are delivered in the foregoing Probleme: Therefore we shall at first come to an Example.

I would make a Dyal upon a Plain in London's Latitude, Declining from the South Westwards 25 Degrees, and Inclining towards the Horizon by the space of an Arch containing 14 Degrees. Having first described on the Plain a Semi-Circle, as was directed Prob. 4. I Rectifie the Globe, Quadrant of Altitude

Altitude, Colure, and Hour-Index, as by the same Probleme, and bring the lower end of the Quadrant of Altitude to the Degree of the Plains Declination, viz. to 25 Degrees counted from the South Westwards, and the ends of the Gnomonical Semi-Circle to the Degrees of Azimuth between which the Plain lies, viz. to 25 Degrees from the West Northwards, and 25 Degrees from the East Southwards; and the middle of the Gnomonical Semi-Circle to the Degree of the Plains Inclination, viz. 14 Degrees counted from the Zenith downwards on the Quadrant of Altitude: Then counting the Degrees of the Gnomonical Semi-Circle contained between the middle of the same and the Brazen Meridian, I find 5 Degrees 30 Minutes; Therefore I number in the Semi-Circle described on the Plain from the Perpendicular Westwards 5 Degrees 30 Minutes, viz. from B to C, and there place the 12 a Clock Line. For finding all the Fore-Noon Hour distances

I turn the  $\left\{ \begin{array}{l} 11 \\ 10 \\ 9 \\ 8 \end{array} \right\}$  a Clock, or till 15 Deg. of the  $\left\{ \begin{array}{l} 20.5 \\ 36.7 \\ 56.24 \\ 76.31 \end{array} \right\}$  counted from Globe East-wards till the Equator pass through the Meridian, and find the Colure Cut the Gnomon Semi-circle in

And these are the distances of all the Fore-Noon Hour Lines, to which several distances I make Pricks on the West side the Semi-circle on the Plain, viz. from B to C.

The After-noon Hour Lines are found bringing the Colure again to the Meridian and the Index of the Hour circle to 12. For then

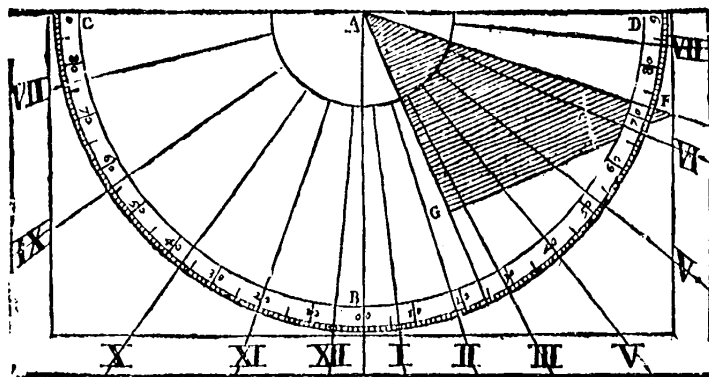
turning the  $\left\{ \begin{array}{l} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{array} \right\}$  a Clock, or till 15 Degrees of the Equator pass through the Meridian, I find the Colure Cut the Gnomonical Semi-circle in  $\left\{ \begin{array}{l} 6.20 \\ 18.2 \\ 28.45 \\ 39.56 \\ 52.30 \\ 67.19 \\ 84.63 \end{array} \right\}$  counted from the middle of the Gnomonical Semicircle.

And these are the distances of the After-noon Hour Lines which I also Prick down at their respective distances from the Perpendicular Eastwards, viz. from B towards D on the Plain, and by drawing Lines from the Center A through all the Pricks, I have all the Hour Lines that this Plain will admit of.

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Having

Having drawn the Hour Lines, I remove the lower end of the *Quadrant of Altitude* to the Deg. of the *Horizon* opposite to the Degree it was at before, viz. to 25 Degrees from the *North Eastwards*, which is so much as the *Declination* is *Westward*; but I let the *Gnomonical Semi-Circle* stand as it did, and turn about the *Globe* till the *Colure* Cuts the *Quadrant of Altitude* in 14 Degrees counted from the *Horizon* upwards, which is the *Inclination* of the *Plain*: Then I find 24 Degrees 3 Minutes comprehended between the middle of the *Gnomonical Semi-Circle* and the *Brass Meridian*, which is the distance of the *Substyle* from the *Perpendicular*: and this distance I count *Westwards* on the *Plain*, because the middle of the *Semi-Circle* lies *Westwards* on the *Globe*, and draw the Line AG through it for the *Substyle*: And I find the *Gnomonical Semi-Circle* Cut the *Colure* in 48 Degrees 5 Minutes, for the Heigh that the *Style* must be Elevated over the *Substyle*. Therefore I make a Prick on the *Plain* 48 Degrees 5 Minutes distant from the *Substyle*, and through that Prick I draw the Line AF to represent the *Style* or *Gnomon*; Then I let fall the *Perpendicular* FG upon the *Substyle* AG, so is there a Triangle made; which if it be Erected



Perpendicularly upon the *Substyle* A G the *Style* A F shall be Parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

Having made this *Dyal* you have also four *Dyals* made; as well as in the former Probleme: For this is one; and its opposite, viz. *North Declining Eastwards* 25 Degrees, *Reclining* 76 Degrees is another; The *South Declining Eastwards* 25 Degrees

Incli-

*Inclining* 14 Degrees is another, and its opposite, viz. *North Declining Westwards* 25 Degrees *Reclining* 76 Degrees is another.

### PROB. XIV

To find in what Place of the Earth any manner of Plain that in your Habitation is not Horizontal, shall be Horizontal.

IT was said in the *Preface* that all manner of *Plains* however Situate are Parallel to some Country or other on the *Earth*: Therefore all manner of *Plains* are indeed *Horizontal Plains* and the distances of the Hour Lines to be described on them may be found as the distances of the Hour Lines of the *Horizontal Dyal* in Prob. 3. It rests now to learn in what Place of the *Earth* any *Plain* that is not *Horizontal* in your Habitation shall become *Horizontal*: And for help of your Understanding herein, Take these following Rules.

1. If your *Plain* be *Erect Direct North*, or *South*, it shall be an *Horizontal* in the same *Longitude* at 90 Degrees distance on the *Meridian* (counted from the *Zenith* of your Place) through the *Equinoctial*. See an *Example* of this in Prob. 4. where I have reduced an *Erect Direct Dyal*, to an *Horizontal*. Thus an *Erect Plain* under the *Pole* is an *Horizontal* under the *Equator*; and an *Erect Direct* in 80 Degrees *North Latitude* is in the same *Longitude* an *Horizontal* at 10 Degrees *South Latitude*. An *Erect Direct* in 70 Degrees *North Latitude*, is in the same *Longitude*, an *Horizontal* at 20 Degrees *South Latitude*: and so to any other Degrees of *Latitude* (as aforesaid) till you come to 45 Degrees *Latitude*: where an *Erect* is an *Horizontal*, and an *Horizontal* an *Erect*: Only as the Hour Lines of the *Horizontal* (being turned Downwards) are numbred from the Right Hand towards the Left, in the *Erect Direct Dyal* they are numbred from the Left Hand towards the Right.

2. If your *Plain* be *Erect Declining*, it shall be an *Horizontal Plain* at that point on the *Globe* which is against the Degree of *Declination*, found in the *Horizon*.

But note, If your *Plain Declines Westwards*, the *Sun* comes sooner to the *Meridian* of it, than to the *Meridian* of the Place

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where

where it becomes an *Horizontal Plain*, and that by so many Hours or Minutes as the Degrees of the difference of *Longitude* between the two Places converted into *Time* amounts to. If it *Declines Eastward*, the *Sun* comes so much later to the *Merid.* of it: And for this Cause (though the making this *Dyal* be the same with an *Horizontal Dyal* for another Place, yet in Respect of *Time*) there will be a difference between them.

### Example.

I would make the *North Dyal Declining East* 63 Degrees, as in Prob. 9. by the *Plain* of the *Horizon*: First I seek in what Place of the *Earth* it shall become an *Horizontal Plain*: Thus, I Elevate the *Pole* of the *Globe* 51  $\frac{1}{2}$  Degrees above the *Horizon*, and bring the *Vernal Colure* to the *Meridian*; then I count from the *South Point* in the *Horizon Eastwards* 27 Degrees, and on the Point on the *Globe* directly against those 27 Degrees I make a Prick for the Place where a *Plain* that *Declines* 63 Degrees from the *North Eastwards* at *London* shall be *Horizontal*; or which is all one, this *Declining Plain* at *London* shall ly in the *Horizon* of that Prick: This Prick for distinction sake we shall hereafter call the *Horizontal Place*: Then by Prob. 1. of the Second Book, I examine the *Latitude* and *Longitude* of this *Horizontal Place*, and find *Latitude* 33 40 *South*; and *Longitude* from the *Colure* 33 Degrees, which is the difference of *Longitude* between *London* and the *Horizontal Place*: which being converted into *Time*, by allowing for every 15. Degrees 1. Hour of *Time*, gives 2. Hours 12. Minutes that the *Sun* comes sooner to the *Meridian* of the *Horizontal Place*, than to the *Meridian* of the *Plain* at *London*: so that when it is 12. a Clock There, it will be but 9. a Clock 48. Minutes Here; when 12 a Clock Here, it will be 2. a Clock 12. Minutes There, &c.

Having thus found in what *Longitude* from *London* and *Latitude* this *Plain* is Parallel to the *Horizon*, I seek the distance of the Hour-lines upon the *Plain* of the *Horizon*. Thus, I Elevate the *Pole* of the *Globe* to the Height of the *Pole* in the *Horizontal Place*, viz. 33. Degrees 40 Minutes, and bring the *Horizontal Place* on the *Globe* to the *Meridian*, and the *Index* of the *Hour Circle* to 12. Then I examine the Degree of the *Horizon* the *Colure* Cuts, and find it 19  $\frac{1}{4}$  from the *South Westwards*, This 19  $\frac{1}{4}$  Degrees

Degrees represents the *Meridian Line* of the *Horizontal Place*: And also the *Substyle* Line here at *London*; Therefore this 19  $\frac{1}{4}$  Degrees I count from the Perpendicular AB of the *Plain*, and from the Center A draw the Line AG through them; Because from this Line on the *Plain* all the Hour Lines must be numbred, and not (as all along hitherto) from the Perpendicular of the *Plain*. Then

turning the	11	a Clock: or till 15	10. 2	} counted from the Meridian.
Globe East-	10	Deg. of the Equa-	0.45	
wards till	9	tor pass through	6.12	
the Index	8	the Meridian; I	15.25	
pointsto	7	find the Colure	26.11	
	6	Cut the Horizon	40.30	
	5	in	60. 0	

And these are the distances of the Fore-noon Hour Lines: which distances I transfer by Pricks to the *Plain*. But as in Prob. 9 I sought the distances from the Perpendicular on the *Plain*, so now in this Case (as was said before) I seek them from the *Substyle*, & through these Pricks I draw Lines from the Center, as in other *Dyals*, and these Lines shall be the Fore-Noon Hour Lines.

To find the After-noon Hour distances, I bring the *Horizontal Place* on the *Globe* again to the *Meridian*, and the *Index* of the *Hour Circle* to 12, and

turning the	1	a Clock, or till 15 Deg. of the	31. 5	} counted from the Meridian.
Globe West-	2	Equator pass through the Me-	46.32	
wards till the	3	ridian, I find the Colure Cut the	68. 5	
Index pointsto	4	Horizon in	95.37	

And these are distances of all the After-noon Hour Lines; which I also transfer to the *Plain*, counting them from the *Substyle*, and draw Lines from the Center A through the distances; and these Lines shall be the After-noon Hour Lines.

Then from the *Substyle* I count the Degrees and Minutes of the *Latitude* of the *Horizontal Place*, viz. 33 Degrees, and through these Degrees and Minutes I draw the Line AF from the Center A for the *Style*: Then from the *Style* I let fall the Perpendicular FG upon the *Substyle*, so is there a Triangle made; which if it be erected perpendicularly upon the *Substyle* AG, the *Style* AF shall be parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

3. If your *Plain* be a *Direct Recliner*, Seek in the *Longitude* of your Place the Complement to 90 of your *Plains Reclination*. For there a *Direct Recliner* becomes an *Horizontal Plain*.

4. If your *Plain* be a *Declining Recliner*: The *Globe* and *Quadrant of Altitude* Rectified, Bring your Habitation on the *Terrestrial Globe* to the *Meridian*, and the *Quadrant of Altitude* to the *Declination*, as by the Second Rule in this Probleme; and count upwards on the *Quadrant of Altitude* the *Reclination*, and there make a Prick on the *Globe* by the side of the *Quadrant of Altitude*, for at that Prick on the *Globe* the *Declining Recliner* shall become an *Horizontal Plain*; then examine the *Latitude* of that Prick as by Prob. 1 of the Second Book, and the difference of *Longitude* as by Prob. 9. of the Third Book, and convert the difference of *Longitude* into *Time*, by allowing for every 15 Degrees 1 Hours *Time*, for every Degree 4 Minutes *Time*, and so proportionably, so shall you know what Hours and Minutes the *Sun* comes sooner or later to the *Meridian* of your Habitation than to the *Meridian* of that Place where it becomes an *Horizontal Plain*; Sooner, if the *Globe* were turned *Eastwards*; but Later if it were turned *Westwards*.

Having thus found out where this *Plain* becomes *Horizontal*, make your *Dyal* to this *Plain*, as by the second Rule in this Probleme: Find also the *Style* as is there directed.

5. If your *Plain* be a *Declining Incliner*, the *Globe* and *Quadrant of Altitude* Rectified, Bring the *Colure* to the *Meridian*, and the *Quadrant of Altitude* to the Degree of the *Horizon* opposite to the Degree of the *Plains Declination*, and count upwards on the *Quadrant of Altitude* the Degrees of *Inclination*, and make a Prick there; For in the *Antipodes* of that Prick (found as by Prob. 29 of the Second Book) that *Declining Incliner* shall become an *Horizontal Plain*. Then find the *Latitude* and difference of *Longitude* of this *Antipodes*, by the former Rule, and make a *Dyal* to that *Plain*, as by the second Rule in this Probleme. Find also the *Style* as therein is directed.

PROB.

PROB. XV.

To make a *Dyal* on the Ceiling of a Room, where the Direct Beams of the Sun never come.

Find some convenient place in the *Transum* of a Window to place a small round piece of Looking-Glass, about the bigness of a Groat, or less, so as it may lie exactly *Horizontal*: The point in the middle of this *Glass* we will mark A, and for distinctions sake (with Mr. Palmer) call it *Nodus*. Through this *Nodus* you must draw a *Meridian Line* on the Floor, Thus: Hang a Plumb-line in the Window exactly over *Nodus*, and the Shadow that the Plumb-line casts on the Floor just at Noon will be a *Meridian-line*; Or you may find a *Meridian-line* otherwise, as by the Preface. Having drawn the *Meridian-line* on the Floor; find a *Meridian-line* on the Ceiling, thus: Hold a Plumb-line to the Ceiling, over that end of the *Meridian-line* next the Window; If the Plumb-line Hang not exactly on the *Meridian-line* on the floor remove your Hand on the Ceiling one way or other, as you see cause till it do Hang quietly just over it, and at the point where the Plumb-line touches the Ceiling make a mark, as at B, that mark B shall be directly over the *Meridian-line* on the Floor: then remove your Plumb-line to the other end of the *Meridian-line* on the Floor, and find a point on the Ceiling directly over it, as you did the former point, as at C, and through these two points B and C on the Ceiling strain and strike a Line Blackt with Smal-Coal or any other Colour (as Carpenters do) and that Line BC on the Ceiling shall be a *Merid. line* as well as that on the Floor: Then examine the *Altitude* of the *Equinoctial* as by Prob. 6. of the Second Book you did the *Merid. Altitude* of the *Sun*, and fasten a String just on the *Nodus*, and remove that String in the *Meridian-line* on the Ceiling till it have the same Elevation in a *Quadrant*, that the *Equinoctial* hath in your Habitation, and through the point where the String touches the *Meridian-line* in the Ceiling shall a Line be drawn at right Angles with the *Merid.* to represent, the *Equinoctial Line*. Thus in our *Latitude* the Elevation of the *Equator* being  $38\frac{1}{2}$  Degrees; I remove the String fastned to the *Nodus* forwards or backwards in the *Meridian-line* of the Ceiling

Ceiling, till the Plumb-line of a Quadrant when one of the Sides are applyed to the String, falls upon  $38\frac{1}{2}$  Degrees, and then I find it touch the *Meridian* line at D in the Ceiling: therefore at D I make a Mark, and through this Mark strike the Line DE (as before I did the *Merid.* Line) to Cut the *Meridian* line at Right Angles: This Line shall be the *Equinoctial* Line.

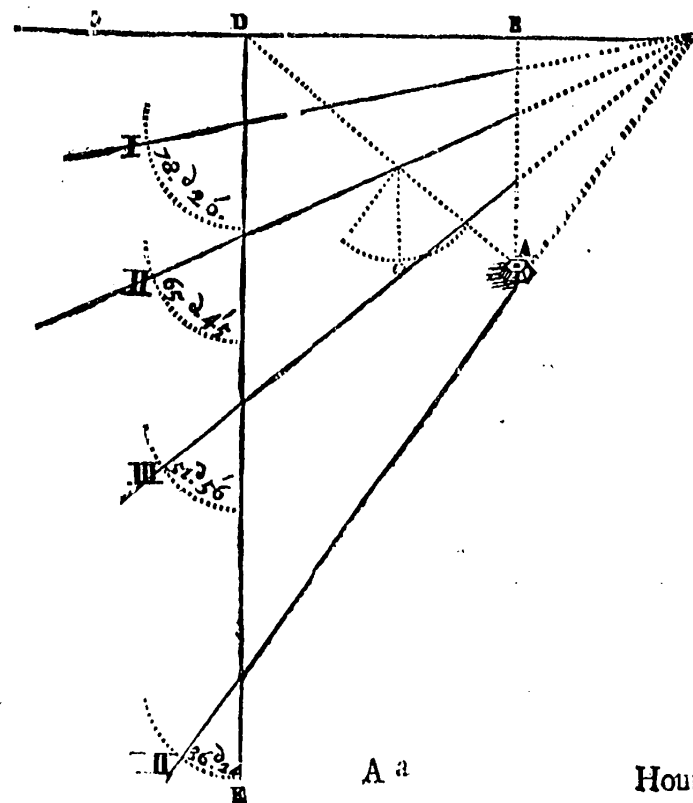
Then I place the Center of the *Semi-Circle of Position* upon *Nodus*, and under-prop it so, that the Flat side of it may ly Parallel to the String when it is strained between the *Nodus* and the *Equinoctial*, and also so as the String may ly on the division of the *Semi-Circle of Position* marked 0, when it is held up to the *Meridian* line in the Ceiling. Then removing the String the space of 15 Deg. in the *Circle of Position* to the *Eastwards*, and extending it to the *Equa.* on the Ceiling, where the String touches the *Equa.* there shall be a point through which the 1 a Clock Hour-line shall be drawn: and Removing the String yet 15 Deg. further to the *Eastwards* in the *Semi-Circle of Position*, and extending it also to the *Equator*, where it touches the *Equator*, there shall be a point through which the 2 a Clock Hour-line shall be drawn. Removing the String yet 15 Degrees further to the *Eastwards* in the *Semi-Circle of Position*, and extending it to the *Equator*, there shall be a point through which the 3 a Clock Hour-line shall be drawn: The like for all the other After-noon Hour Lines; so oft as the String is removed through 15 Degrees on the *Semi-Circle of Position*, so oft shall it point out the After-noon distances in the *Meridian* line on the Ceiling.

The Situation of the *Semi-Circle of Position* cannot conveniently be shewn in this Figure, unless it be drawn by the Rules of *Perspective*; neither if it were, would it suit with the other Demonstrations, except they were drawn by the same Rules also which to do would be hard for young Learners to understand: Therefore I have left out the *Semi-Circle of Position* in this Figure, and refer you for a Demonstration thereof to the sixth Problem; for even as the Lines drawn through every 15 Degrees of the *Semi-Circle of Position* there denote in a *Contingent* line the distance of any Hour-line from the *Meridian* line, even so a Line drawn through every 15 Degrees of the *Semi-Circle of Position* posited (as aforesaid) point out the *Equinoctial* line on the Ceiling the distance of each respective Hour-line from the *Meridian* line.

Having

Having thus found out the points in the *Equator* through which the After Noon Hour-lines are to be drawn, I may find the Fore-noon Hour distances also the same way, viz. by bringing the String to the several 15 Degrees on the *West* Side the *Semi-Circle of position*; or else I need only measure the distances of each Hour distance found in the *Equator* from the *Meridian* line on the Ceiling; for the same number of Hours from 12 have the same distance in the *Equinoctial* Line on the other side the *Meridian* both before and After Noon: The 11 a Clock Hour distance is the same from the *Meridian* line with the 1 a Clock distance on the other side the *Merid.* the 10 a Clock distance, the same with the 2 a Clock distance, the 9 with the 3, &c. And thus the distances of all the Hour Lines are found out on the *Equa.*

Now if the Center of this Dyal lay within Doors you might draw Lines from the Center through these Pricks in the *Equa.* and those Lines should be the Hour Lines, as in other Dyals: But the Center of this Dyal lies without Doors in the *Air*, and therefore not convenient for this purpose: so that for drawing the





Hour lines you must consider what Angle every Hour Line in an *Horizontal Dyal* makes with the *Meridian*; that is, at what distance in Degrees and Minutes the Hour Lines of an *Horizontal Dyal* Cut the *Meridian*; which you may examine as by Prob. 3. for an Angle equal to the Complement of the same Angle, must each respective Hour Line with the *Equator* on the Ceiling have.

Thus upon the point mark for each Hour distance in the *Equinoctial* Line on the Ceiling, I describe the Arches I, II, III, IV, as in the *Figure*, and finding the distance from the *Meridian* of the Hour Lines of an *Horizontal Dyal* to be according to the third Probleme. Thus

The  $\left. \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} \right\}$  a Clock Hour-line  $\left\{ \begin{matrix} 11.40 \\ 24.15 \\ 38.14 \end{matrix} \right\}$  whose Complement to.  $\left\{ \begin{matrix} 78.20 \\ 65.45 \\ 51.56 \end{matrix} \right\}$  90 is  $\left\{ \begin{matrix} 53.36 \\ 36.24 \end{matrix} \right\}$

I measure in a *Quadrant* of the same *Radius* with those Arches already drawn from the *Equinoctial* Line.

for the  $\left. \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix} \right\}$  a Clock Hour  $\left\{ \begin{matrix} 78.20 \\ 65.45 \\ 51.56 \\ 36.24 \end{matrix} \right\}$

and transfer these distances to the Arches drawn on the Ceiling: For then straight Lines drawn through the mark in the Arch, and through the mark in the *Equator*, and prolonged both waies to a convenient Length, shall be the several Hour Lines (aforesaid;) And when the *Sun* Shines upon the Glass at *Nodus*, its Beams shall reflect upon the Hour of the Day.

#### PROB. XVI.

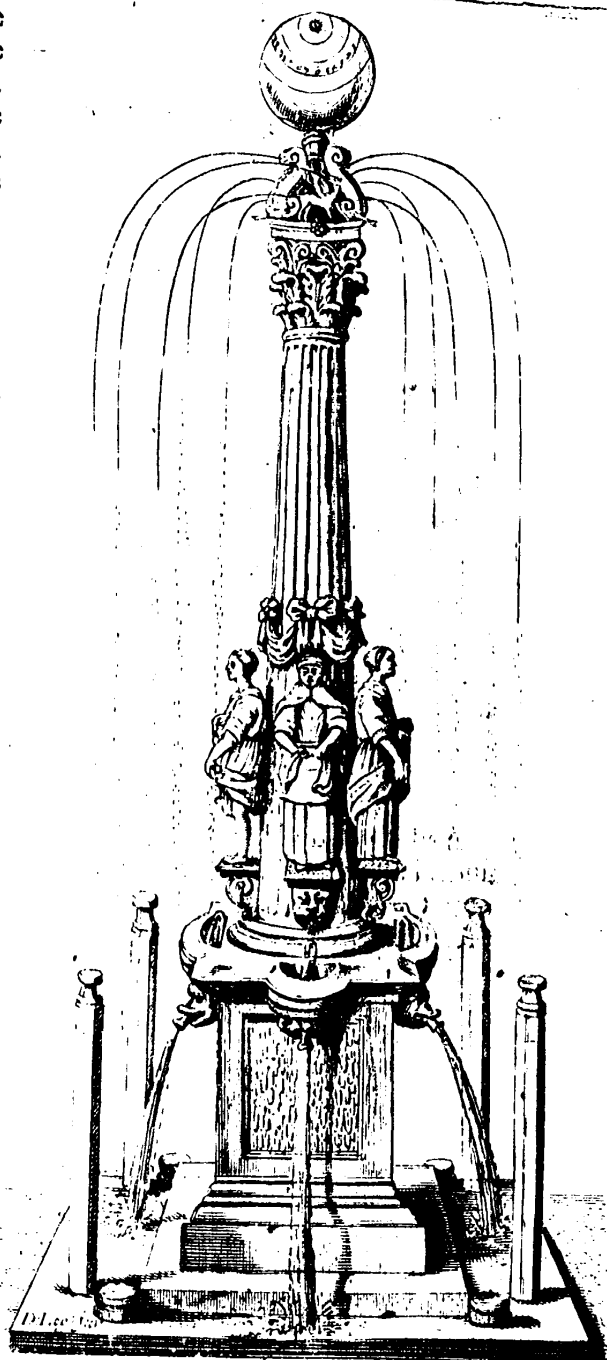
To make a Dyal upon a solid Ball or Globe, that shall shew the Hour of the Day without a Gnomon,

THE *Equinoctial* of this *Globe*, or (which is all one) the middle Line must be divided into 24. equal parts, and Marked with 1, 2, 3, 4, &c. to 12 and then beginning again with 1, 2, 3, &c. to 12. Then if you Elevate one of the *Poles* so many Deg. above an *Horizontal-Line* as the *Pole* of the *World* is Elevated above the *Horizon* in your Habitation, and place one of the 12 directly to Behold the *North*, and the other to Behold the

the *South*: when the *Sun* Shines on it, the *Globe* will be divided into two Halves, the one Enlighted with the *Sun-shine*, and the other Shadowed: and where the Enlightened Half is parted from the Shadowed Half, there you shall find in the *Equinoctial* the Hour of the Day; and that on two Places on the Ball; because the *Equinoctial* is Cut in two opposite Points by the Light of the *Sun*.

A Dyal of this Sort was made by Mr. John Leek, and set up on a Composite Columne at *Leaden Hall* Corner in *London*, in the *Majesty* of Sr. John Dethick, Knight. The *Figure* whereof I have inserted, because it is a pretty piece of Ingeniety, and may perhaps stand some Lover of Art in stead either for Imitation, or help of Invention.

A 2 2 PROB.



## P R O B. XVII.

*To make a Dyal upon a Glas: Globe, whose Axis shall cast a Shadow upon the Hour of the Day.*

**F**irst divide the *Equinoctial* of your *Globe* into 14 equal parts; and having a Semi-Circle cut out of some *Brass* plate, or thin *Wood*, to the same *Diameter* your *Globe* is of, or a very little wider: Apply this Semi-Circle to the *Globe*, so as the upper edge of each end of the Semi-circle may touch the *Poles* of the *Globe*, and the middle of the Semi-circle may at the same edge Cut through some division made in the *Equinoctial*: for then a Line drawn by the edge of the Semi-circle thus posited shall be a *Meridian*-line: The same way you must draw *Meridian*-lines through every division of the *Equinoctial*, and set Figures to them, beginning with 1, 2, 3, 4, &c. to 12, and then beginning again with 1, 2, 3, 4, &c. to 12 again. This *Globe* being made of *Glass*, and having an *Axis* of *Wyer* passing through it from *Pole* to *Pole*, will be an *Horizontal Dyal* all the *World* over, if its *Axis* be set Parallel to the *Axis* of the *World* in the same Place; and one of the *Meridians* marked 12 be set so as it may directly behold the *North* point in *Heaven*, and the other the *South* point in *Heaven*, for then the *Axis* of the *Globe* shall cast a Shadow upon the Hour of the Day.

And if you divide the upper Half of the *Glas* *Globe* from the under half, when the *Axis* stands Parallel to the *Axis* of the *World* by a Circle drawn round about the *Globe*, that Circle shall represent the *Horizon*: and the *Meridian*-lines drawn one the *Globe* shall be the *Hour*-lines, and have in the *Horizontal* Circle the same distance from the 12 a Clock Line that the same respective *Hour* Line was found to have, as by Prob. 3. of this Book.

But because the Shadow of this *Axis* will not be discerned through the *Glas* *Body*, therefore you may with *Water* and *White Lead* ground together lay a Ground on the Inside of the under Half of the *Glas* to the *Horizontal* Circle (as *Looking-glass*-makers do their *Looking-Glasses* with *Tin* foil) for then the Shadow will appear.

Such a *Glas* *Globe* *Dyal* had *Robert Titchborn*, once Lord Mayor of *London*, standing in his Garden supported by *Atlas*.

*The End of the Fifth Book.*

The



The Sixth BOOK,  
Shewing the Practical Use of the  
**G L O B B S.**  
*Applying them to the Solution of*  
**Spherical Triangles.**

P R Æ F A C E.

**T**HE Solution of Spherical Triangles is to know the Length of their Sides, & the Width of their Angles. These have already by many Learned Men been Taught to be performed by a Canon of Sines and Tangents; and also by many Instruments, Some serving as Tables of Sines and Tangents; such as are the Sectors, Scales, the Spiral Line, &c. And others Serving to represent the Globe: such as be the Mathematical Jewel, Astrolabium Catholicum, and several other Projections of the Sphear. But none hath as yet Taught the Solution of Spherical Triangles by the Globe it Self; though it be the most Natural, and most Demonstrative Way of all, and indeed ought first to be learnt before the Learner enters upon any other Way.

To this Authors of Trigonometry agree; for the most of them in their Books give Caution that the Learner be already

already sufficiently grounded in the Principles of the Globe: For those Lines or Circles which either in Tables or other Instruments you force your Imagination to conceive, represent your Line or Circle in Question, those Lines and Circles (If any) you have Actually and Naturally described on the Globe, & therefore may at a Single Operation, or perhaps only by a sudden Inspection, have an Answer annexed, according as the Nature of your Question shall require: and that more Copiously than by Tables of Sines and Tangents: For therein you find but one Question at once Resolved. But by the Globe you have always two Resolved together.

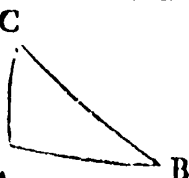
Of the Parts and Kinds of Spherical Triangles.

THEOREMS.

1. **A**LL Spherical Triangles are made of six Parts; Three Sides and three Angles. The Sides are joynd together at the Angles, and Measured by Degrees of a Great Circle from one end to the other. The Angles are the Distance of the two joynd Sides: and they are also measured by an Arch of a Circle, described on the Angular Point. If any Three of these Parts be Known, the rest may be Found.
2. All Spherical Triangles are either Right Angled or Oblique Angled. A Right Angle contains 90 Degrees: An Oblique Angle either More, or Less.
3. If a Spherical Triangle have one or more Right Angles; it is called a Right Angled Spherical Triangle. But if it have no Right Angle; it is called an Oblique Angled Spherical Triangle.
4. If an Oblique Spherical Triangle have one Angle Greater than a Right Angle, it is called an Obtuse Angled Spherical Triangle. But if it have no Angle Greater, it is called an Acute Angled Spherical Triangle.
5. In Right Angled Triangles the Sides including the Right Angle are called Legs: And the Side Opposite to the Right Angle

gle is called *Hypothenuſa*. Thus the *Sides* AB and AC in the following *Triangle* are called *Legs*; and the ſides BC is called *Hypothenuſa*.

6. In a *Right angled Spherical Triangle* one of the *Legs* are called *Base*; the other A *Perpendicular*: Thus the Leg AB is *Base*: and the Leg CA *Perpendicular*. But the Terms may be Varied: for the *Base* may be made *Perpendicular*, and the *Perpendicular Base*. Alſo One of the adjacent *Angles* is called the *Angle at the Base*; the other the *Angle at the Perpendicular*: Thus the Angle B is called the *Angle at the Base*: The Angle C the *Angle at the Perpendicular*.



### PROB. II.

*The Legs of a Right Angled Spherical Triangle given, to find the Hypothenuſa, and the two other Angles.*

*Nota*

THE *Base* of a *Right Angled Spherical Triangle* ſhall in this following Treatiſe be always placed on a *Meridian*, the *Perpendicular* on the *Equator*, the *Hypothenuſa* on the *Quadrant of Altitude*, and the *Angle at the Base* ſhall be meaſured in an *Arch* of the *Horizon*.

Elevate the *Equinoctial* into the *Zenith*, ſo ſhall the *Poles* of the *Globe* lie in the *North* and *South* Points of the *Horizon*.

Then count from the *Equinoctial* on the *Meridian*, if you uſe the *Terreſtrial Globe*; or on the *Vernal Colure*, if you uſe the *Celeſtial*, becauſe they are divided from the *Equinoctial* either way into 90 Degrees; and becauſe from thence the Degrees of the *Equinoctial* are begun to be numbred: Count (I ſay) from the *Equinoctial* the number of Degrees the *Base* contains, and there make a Prick: Then count in the *Equinoctial* from the *First Meridian* the number of Degrees the *Perpendicular* contains, and make there a Second Prick: Bring that Second Prick to the *Brazen Meridian*, ſo ſhall the *First Meridian* be ſeparated from the *Brazen Meridian* by the quantity of an *Arch* equal to the meaſure of the *Perpendicular*: Then having the *Quadrant of Altitude* ſcrewed in the *Zenith*, Turn it about till the ſide of it Cut the Prick made in the *First Meridian*; ſo ſhall the

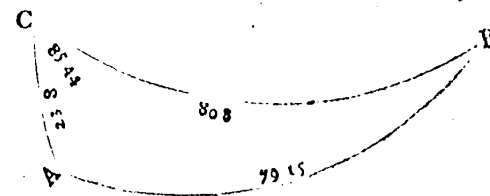
*Triangle*

*Triangle* be repreſented on the *Globe*. The *Base* ſhall lie on the *First Meridian* between the *Equinoctial* and the *Quadrant of Altitude*, the *Perpendicular* in the *Equinoctial* between the *First Meridian* and the *Brazen Meridian*; and the *Hypothenuſa* on the *Quadrant of Altitude* between the *Zenith* and the *First Meridian*; and the number of Degrees between each of theſe reſpective *Arches* ſhall be the Meaſure of each reſpective *Side*. For the *Angles*; The *Right Angle* is known to be 90 Degrees, by the Second Theorem in the Preface. The Meaſure of the *Angle at Perpendicular* is numbred between the *East Point* in the *Horiz.* and the *Graduated edge* of the *Quadrant of Altitude*: But to find the *Angle at the Base* you muſt turn the *Triangle*, making the *Perpendicular Base*, and the *Base Perpendicular*.

### Example.

Having the two *Legs* given AB 79 Degrees 15 Minutes, and CA 23 Degrees 8 Minutes, I would find the Meaſure of the *Hypothenuſa* CB, and the *Angles* B, C.

The *Equinoctial* Elevated as before, I make AB *Base*, and C A *Perpendicular*, counting in the *First Meridian* from the *Equinoctial* 79 Degrees 15 Minutes, and there I make a Prick: Then I number in the *Equinoctial* from the *First Meridian* 23 Degrees 8 Minutes the Length of the *Perpendicular*, and there I make a Second Prick: This Prick I bring to the *Brazen Meridian*, ſo is the *First Meridian* ſeparated from the *Brazen Meridian* ſo many Degrees and Minutes as is the Length of the

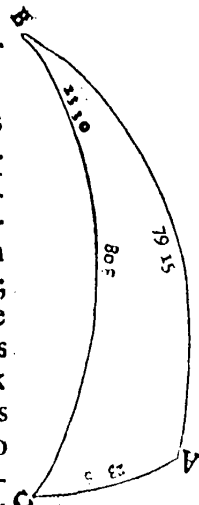


*Perpendicular* CA: Then I ſcrew the *Quadrant of Altitude* to the *Zenith*, viz. directly over the *Equinoctial*, and move it about till the *Edge* of it touch the Prick made in the *First Meridian*: So is the *Triangle* made on the *Globe*: And the number of Degrees and Minutes of the *Quadrant of Altitude* comprehended between the *First Meridian* and the *Zenith* is the Meaſure of the *Hypothenuſa* CB; which in this Example is 80 Degrees 8 Minutes: The number of Degrees in the *Horizon* compre-

B b

hended between the *Equinoctial* and the *Quadrant of Altitude* is the Measure of the *Angle C*, 85 Degrees, 44 Minutes: the *Angle A* is a *Right Angle*, 90 Degrees: And to find the *Angle B* Turn the *Triangle* (all but the Letters;) Thus as before *AC* was *Base*, so now I make *BA* *Base*; and as before *AB* was *Perpendicular*, so now *CA* shall be *Perpendicular*: so is your *Triangle* Turned.

Now, as before I counted 79 Degrees 15 Minutes from the *Equinoctial* on the *First Meridian*, which was the Length of that *Base*, so now I count 23 Degrees 8 Minutes on the *First Meridian*, which is the Length of this *Base*, and there (as before) I make a Prick; and as before I counted 23 Degrees 8 Minutes on the *Equinoctial* from the *First Meridian*, which was the Length of that *Perpendicular*; so now I count 79 Degrees 15 Min. on the *Equinoctial*, which is the Length of this *Perpendicular*; and there I make a Prick on the *Equinoctial*: Then I bring this Prick (as before to the *Brazen Meridian*, so shall the *First Meridian* be distant (as before) from the *Brazen Meridian* so many Deg. and Min. as is the Length of this *Perpendicular*, viz. 79. 15. Then having the *Quadrant of Altitude* Crewed to the *Zenith*, I turn it about till the Edge of it touch the Prick made in the *First Meridian* at 23. 8. distant from the *Equinoctial*; so is the *Triangle* Turned: And so shall the Arch of the *Horizon* comprehended between the *Equinoctial* and the *Quadrant of Altitude* be the Measure of the *Angle BC*, 23. 30. you also see the Measure of the *Hypothenufa BC* 80. 8. on the *Quadrant of Altitude*, counted between the *Zenith* and the *First Merid.*



### PROB. II.

*A Leg and the Hypothenufa given, to find the Rest.*

**Example.** The *Leg* given shall be *CA* in the former *Triangle* 23 Degrees 8 Minutes, The *Hypothenufa CB* 80 Degrees 8 Minutes. The *Equinoctial* and *Quadrant of Altitude* Rectified, as by the last Probleme; Number the *Leg CA* 23 Degrees

Degrees 8 Minutes on the *Equinoctial* from the *First Meridian*, and there make a Prick; Bring this Prick to the *Brazen Meridian*; Then number on the *Quadrant of Altitude* the *Hypothenufa BC* 80 Degrees 8 Minutes from the *Zenith* towards the *Horizon*, and make there on the Edge of the *Quadrant of Altitude* another Prick: Then turn the *Quadrant of Altitude* about till the Prick made on the Edge of it touch the *First Meridian*, so shall the *Triangle* be made: The Arch of the *Equinoctial* comprehended between the *First Meridian* and the *Brazen Merid.* shall represent *AC* the *Perpendicular*; the Arch of the *Quadrant of Altitude* comprehended between the *Zenith* and the *First Merid.* shall represent *BC* the *Hypothenufa*; and the Arch of the *First Meridian*, comprehended between the *Equinoctial* and the *Quadrant of Altitude* shall represent *BA* the *Base*, which was one *Leg* sought, and is (as you will find) 79 Degrees 15 Minutes: The *Angle C* you will find in the *Horizon* 85 Degrees 44 Minutes: The *Angle A* is the *Right Angle* 90 Degrees: And to find the *Angle B* you must Turn the *Triangle*, as you were directed in the former Probleme.

### PROB. III.

*The Hypothenufa and an Angle given, to find the Rest.*

**THE** *Hypothenufa* given shall be *BC* of the *Triangle* in Prob. I. 80 Degrees 8 Minutes. The *Angle* given shall be *C*, 85 Degrees 44 Minutes: The *Globe* and *Quadrant of Altitude* Rectified as by Prob. I. count the given *Angle* 85 Degrees 44 Minutes on the *Horizon* from the *Equinoctial*, and there place the *Quadrant of Altitude*: Then turn about the *Globe* till the *First Meridian* touch 80 Degrees 8 Minutes of the *Quadrant of Altitude* counted from the *Zenith* downwards, so shall the *Triangle* be made on the *Globe*: The Arch of the *Equator* comprehended between the *First Meridian* and the *Brazen Meridian* shall shew the Length of the *Perpendicular CA* 23 Degrees 8 Minutes; the Arch of the *First Meridian* comprehended between the *Equinoctial* and the *Quadrant of Altitude* shall shew the Length of the *Base AB* 79 Degrees 15 Minutes; the *Right Angle* made at the Interfection of the *Brazen Meridian* and the *Equinoctial* is 90 Degrees: and to find the Measure of the *Angle B* you must Turn the *Triangle*, as you were directed Prob. I.

B.b 2

PROB.

## PROB. IV.

*A Leg and Angle adjoyning given, to find the Rest.*

IN the *Triangle* of Prob. 1. the *Leg* given shall be CA 23 Degrees 8 Minutes, the *Angle* adjoyning shall be C 85 Deg. 44 Minutes: The *Globe* and *Quadrant of Altitude* Rectified, as by Prob. 1. I turn about the *Globe* till the *First Meridian* be distant from the *Brazen Meridian* 23 Degrees 8 Minutes, the Length of the *Leg* CA: Then I count in the *Horizon* from the *Equinoctial* 85 Degrees 44 Minutes, the Measure of the *Angle* C; so is the *Triangle* made on the *Globe*. The *Arch* of the *First Meridian* comprehended between the *Quadrant of Altitude* and the *Equinoctial* shall shew the Length of the *Base* AB 79 Degrees 15 Minutes; The *Arch* of the *Quadrant of Altitude* comprehended between the *Zenith* and the *First Meridian* shall shew the Length of the *Hypotenusa* CB 80 Degrees 8 Minutes; The *Right Angle* made at the Intersection of the *Equinoctial* and the *Brazen Meridian* is 90 Degrees: And to find the Measure of the *Angle* B, you must Turn the *Triangle*, as you were directed Prob. 1.

## PROB. V.

*A Leg and the Angle opposite given, to find the Rest.*

IN the *Triangle* of Prob. 1. the *Leg* given shall be AB 79 Degrees 15 Minutes, the *Angle* opposite shall be C 85 Degrees 44 Minutes. The *Globe* and *Quadrant of Altitude* Rectified, as by Prob. 1. I bring the *Quadrant of Altitude* to 85 Degrees 15 Minutes of the *Horizon*, the Measure of the *Angle* C: Then I Turn the *Globe* till 79 Degrees 15 Minutes of the *First Meridian* (which is the Measure of the *Leg* AB) touch the *Quadrant of Altitude*, so is the *Triangle* made on the *Globe*. The *Arch* of the *Equinoctial* comprehended between the *First Meridian* and the *Brazen Meridian* shews the Length of the *Leg* CA 23 Degrees 8 Minutes; the *Arch* of the *Quadrant of Altitude* comprehended between the *Zenith* and the *First Meridian*, shall shew the Length of the *Hypotenusa* CB 80 Degrees 8 Minutes: The *Right Angle* made at the Intersection of the *Equinoctial* and the *Brazen Meridian* is 90 Degrees: And to find the Measure of the *Angle* B, you must Turn the *Triangle*, as you were directed in Prob. 1.

PROB.

## PROB. VI.

*The Angles given to find the Sides.*

IN this *Case* you must Turn the *Angles* into *Sides*, making an *Oblique Triangle* on the *Globe*, whose *Sides* shall be equal to the given *Angles*: so shall the *Angles* of this *Triangle* found, be the Measure of the *Sides* required.

## Example.

In the *Triangle* of Prob. 1. The *Angle* A is 90 Degrees, the *Angle* B 23 Degrees 30 Minutes, the *Angle* C 85 Degrees 44 Minutes: The *Globe* and *Quadrant of Altitude* Rectified as by Prob. 1. I set the *Right Angle* A 90 Degrees on the *Brazen Meridian* between the *Pole* and the *Equinoctial*; For the *Angle* B, I number downwards on the *Quadrant of Altitude* 23 Degrees 30 Minutes, which shall be the *Side* representing that *Angle*: for the *Angle* C I number on the *First Meridian* from the *Pole* towards the *Equinoctial* 85 Degrees 44 Minutes, which shall be the *Side* representing that *Angle*: Then I turn the *Globe* and *Quadrant of Altitude* till I can joyn the 23 Degrees 30 Minutes (counted before on the *Quadrant of Altitude*) and this 85 Deg. 44 Minutes (counted in the *First Meridian*) together; So is a *Triangle* made on the *Globe*, whose *Sides* being equal to the *Angles* given, shall have its *Angles* equal to the *Sides* Required: Thus the *Arch* of the *Equinoctial* contained between the *First Meridian* and the *Brazen Merid.* shall be found 23. 8. the Measure of the *Side* AC: the *Arch* of the *Horizon* between the nearest *Pole* and the *Quadrant of Altitude* shall be found 79. 15. the Measure of the *Side* BA: And to find the *Hypotenusa* ABC, you have now *Data's* enough; either to find it as by some of the former *Problemes*; or else you may find it by Turning the *Triangle*; as by Prob. 1.

These *Cases* of *Right Angled Spherical Triangles* may be Wrought otherwayes by the *Globe*, if you alter its Position, making the *North* or *South* Points of the *Horizon* *Zenith*; or else the *Poles* of the *World*, or the *Poles* of the *Ecliptick*; and use the *Circle of Position* instead of the *First Meridian* or *Circles of Longitude*. But these *Instructions* together with a little *Practice* are (I judge) sufficient: Therefore I shall refer *Varieties* to the studies of the industrious Student.

Of

## Of Oblique Triangles.

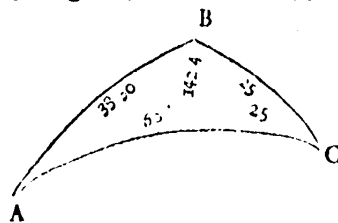
## PROB. VII.

*The three Sides given, to find the Angles.*

Elevate the Pole of the Globe above the Horizon to the complement of one of the given Sides, and screw the Quadrant of Altitude in the Zenith, so shall that given Side be comprehended between the Pole and the Quadrant of Altitude; Then count from the Pole upon the First Meridian the Measure of the Second Side, and there make a Prick: Count also from the Zenith upon the Quadrant of Altitude downwards the Measure of the Third Side, and make there on the Edge of the Quadrant of Altitude another Prick; Then turn the Globe and Quadrant of Altitude till you can joyn these two Pricks together, so shall your Triangle be made on the Globe: And then the number of Degrees of the Equinoctial comprehended between the First Meridian and the Brazen Meridian shall be the Measure of the Angle at the Pole: The Arch of the Horizon contained between the Quadrant of Altitude and the intersection of the Brazen Merid. with the Horizon on the side the Pole is Elevated, shall be the Measure of the Second Angle. For finding the Third, Turn the Triangle, as by Prob. I.

*Example.*

In the Triangle ABC annexed, The Side AB contains 38 Degrees 30 Minutes, the Side BC 25 Degrees, and the Side AC 60 Degrees; I would Measure these Angles; I place one of these Sides upon the Merid. viz. AB 38.30. The Complement of 38.30. is 51 Deg. 30 Min. Therefore I Elevate the Pole 51.30. above the Horiz. so shall the Zenith be distant from the Pole 38.30. here I screw the Quad. of Altitude in the Zenith and count downwards on it the Measure of the Side BC 25 Deg. and there I make a Prick: then from the Pole



I count

I count on the First Meridian 60 Deg. the Measure of the Side AC, and there I make another Prick: Then I turn the Globe and Quad. of Altitude backwards or forwards till these two Pricks are joyned together; so shall the Triangle ABC be made on the Globe: The Arch of the Brazen Meridian comprehended between the Pole and Zenith shall represent the Side AB; the Arch of the Quadrant of Altitude comprehended between the First Merid. and the Brazen Meridian shall represent the Side BC; and the Arch of the First Merid. comprehended between the Pole and the Quadrant of Altitude shall represent the Side AC; The Pole shall represent the Angle A, the Zenith the Angle B, and the intersection of the First Meridian with the Quadrant of Altitude shall represent the Angle C. The Angle at the Pole is Measured in the Equator; for the Degrees comprehended between the First Meridian and the Brazen Meridian being 17 Degrees 15 Min. shews 17 Degrees 15 Minutes to be Measure of the Angle A: The Angle at the Zenith is Measured in the Horizon; for the Degrees comprehended between the Intersection of the Brazen Meridian with the Horizon on that side the Pole is Elevated being 142 Degrees 42 Minutes, shews that 142 Degrees 42 Minutes is the Measure of the Angle B. Thus two Angles are found; the Third is wanting: which I find thus:

I Turn the Triangle, placing either A or C in the Zenith. Example. I place A at the Zenith, which before was at the Pole; so shall C be at the Pole, and B at the Intersection of the First Merid. and the Quadrant of Altitude, and the Side AC shall be comprehended between the Pole and Zenith: The Side AC contains 60 Degrees; its Complement to 90 is 30 Degrees; therefore I Elevate the Pole of the Globe 30 Degrees above the Horizon; so shall 60 Degrees be in the Zenith; therefore to 60 Degrees I screw the Quadrant of Altitude and count on it downwards the measure of the other Side next the Zenith, viz. 38 Degrees 30 Minutes; and there I make a Prick: Then from the Pole on the First Meridian I count the Measure of the Last Side, viz. 25 Degrees, and there I make another Prick: Then I turn the Globe and Quadrant of Altitude (as before) till these two Pricks joyn; so is the Triangle Altered on the Globe: For the Arch of the Brazen Meridian comprehended between the Pole and Zenith which before was 38 Degrees 30 Minutes is now 60 Degrees; the Arch of the Quadrant of Altitude comprehended between



tween the *First Meridian* and the *Brazen Meridian*, which before was 25 Degrees, is now 38 Degrees 30 Minutes, and the *Arch* of the *First Meridian* comprehended between the *Quadrant of Altitude* and the *Pole*, which before was 60 Degrees is now 25 Degrees. Thus the *Angle C* being now at the *Pole*, its Measure is found in the *Equinoctial*, viz. the *Arch* comprehended between the *First Meridian* and the *Brazen Meridian* which is 25 Deg. 24 Minutes; and the Measure of the *Angle A*, which is now in the *Zenith*: having its *Sides* the one an *Arch* of the *Brazen Meridian* the other an *Azimuth* (or which is all one) an *Arch* of the *Quadrant of Altitude*, is Measured in the *Horizon*, as all *Azimuths* are, and found 17 Degrees 15 Minutes, as before.

## PROB. VIII.

*Two Sides and the Angle contained between them given to find the Rest.*

**E**xample, In the former *Triangle* I have given the *Sides A B*, 38 Deg. 30 Min. *AC*, 60 Deg. and the *Angle A* 17 Deg. 15 Min. I Elevate the *Pole* of the *Globe* to the Complement of one of the given *Sides*; suppose the *Side A B*, which being 38 Deg. 30 Minutes Complement to 90 Deg. is 51 Deg. 30 Min. so shall the *Zenith* be distant from the *Pole* 38 Deg. 30 Min. the Measure of the *Side AB*: The other *Side* is 60 Deg. this 60 Deg. I count from the *Pole* in the *First Meridian*, and there I make a *Prick*: The *Angle* given is 17 Deg. 15 Min. this I count in the *Equinoctial* from the *First Meridian*, and this Degree and Minute in the *Equinoctial* I bring to the *Brazen Meridian*, so shall the *First Meridian* be separated from the *Brazen Meridian* 17 Deg. 15 Min. Then I screw the *Quadrant of Altitude* to the *Zenith*, and bring the *Side* of it to the *Prick* made in the *First Meridian*: so shall the *Triangle* be made on the *Globe*. Then to find the unknown *Side BC*, I count the number of Deg. on the *Quadrant of Altitude* contained between the *Zenith* and the *First Meridian*, and find 25 which is the Measure of the *Side BC*: To find the Measure of the *Angle B*, I count the number of Degrees contained between the intersection of the *Merid.* with the *Horizon* on that side the *Pole* is Elevated and the *Quadrant of Altitude*, and find 142 Deg. 42 Min. which is the Measure of the *Angle B*: And to find the *Angle C*, I Turn the *Triangle*, as in Prob. 7.

PROB.

## PROB. IX.

*Two Sides and an Angle opposite to one of them given to find the Rest.*

**E**xample. In the *Triangle* in Prob. 7. the *Sides* given are *A B* 38 Degrees 30 Minutes, and *AC* 60 Degrees: The *Angle* given opposite to *AC* is *B* 142 Degrees 42 Minutes: I Elevate the *Pole* to the Complement of one of the given *Sides*; suppose *AB*, which being 38 Degrees 30 Minutes, its Complement to 90 Degrees is 51 Degrees 30 Minutes; so is the *Zenith* distant from the *Pole* 38 Degrees 30 Minutes: To this 38 Deg. 30 Minutes I screw the *Quadrant of Altitude*, and count in the *Horizon* from the Intersection of the *Meridian* with the *Horizon* on that side the *Pole* is Elevated the Measure of the given *Angle B*, viz. 142 Degrees 42 Minutes, and to this number of Degrees and Minutes of the *Horizon* I bring the Edge of the *Quadrant of Altitude*; then I count in the *First Meridian* from the *Pole* the Measure of the *Side AC* 60 Degrees; and there I make a *Prick* and turn about the *Globe* till that *Prick* come to the Edge of the *Quadrant of Altitude*, so is the *Triangle* made on the *Globe*: the Degrees of the *Quadrant of Altitude* comprehended between the *First Meridian* and the *Zenith* being 25 Degrees, is the Measure of the *Side BC*: The Degrees of the *Equinoctial* comprehended between the *First Meridian* and the *Brazen Meridian* being 17 Degrees 15 Minutes, is the Measure of the *Angle A*: and for finding the Measure of the *Angle C*, I Turn the *Triangle*, as in Prob. 7.

## PROB. X.

*Two Angles and the Side comprehended between them given, to find the Rest.*

**E**xample. In the *Triangle* of Prob. 7. the *Angles* given are *A* 17 Degrees 15 Minutes, and *B* 142 Degrees 42 Minutes, the *Side* comprehended between them is *AB* 38 Degrees 30 Minutes; I Elevate the *Pole* to the Complement of the *Side AB*, which being 38 Deg. 30 Minutes, its Complement to 90 Degrees

C c

grees

grees is 51 Degrees 30 Minutes, so is the *Zenith* distant from the *Pole* 38 Degrees 30 Minutes; to this 38 Degrees 30 M. I screw the *Quadrant of Altitude*, and count in the *Horiz.* from the Intersection of the *Meridian* with the *Horizon* on that side the *Pole* is Elevated the Measure of the given *Angle B*, viz. 142 Degrees 42 Minutes, and to this number of Deg. and Minutes of the *Horizon* I bring the Edge of the *Quadrant of Altitude*; then I turn about the *Globe* till the *First Meridian* is distant from the *Brazen Meridian* 17 Deg. 15 Minutes of the *Equinoctial* which is the Measure of the other given *Angle*; So shall the *Triangle* be made on the *Globe*: and the *Arch* of the *Quadrant of Altitude* comprehended between the *First Meridian* and the *Zenith* shall be the Measure of the *Side BC* 25 Degrees, and the *Arch* of the *First Meridian* comprehended between the *Pole* and its Intersection with the *Quadrant of Altitude* shall be the Measure of the *Side AC* 60 Degrees. The Measure of the *Angle C* is found by Turning the *Triangle*, as in Prob. 7.

## P R O B. XI.

*Two Angles and a Side opposite to one of them given, to find the Rest.*

**E**Xample. In the *Triangle* of Prob. 7. the *Angles* given are A 17 Degrees 15 Minutes, and B 142 Degrees 42 Minutes, the *Side* given is BC 25 Degrees being the *Side* opposite to the *Angle A*; the *Angle A* is made at the *Pole* of the *Globe*, and Measured in the *Equator*: Therefore I separate the *First Merid.* from the *Brazen Meridian* 17 Degrees 15 Minutes, so doth the *Pole* represent the *Angle A*; the *Angle B* is made at the *Zenith*, and Measured in the *Horizon*; therefore I count in the *Horizon* 142 Degrees 42 Minutes, and there I make a Prick, to this Prick I bring the Edge of the lower end of the *Quadrant of Altitude*, (not minding to what Degrees of the *Merid.* the upper end of it is placed) Then I count from the upper end of the *Quad. of Altitude* 25 Deg. downwards, the Measure of the *Side BC*, and there I make a Prick, and keeping the lower end of the *Quad. of Altitude* to the Prick made in the *Horiz.* I slide the upper end of it forwards or backwards till the Prick on the *Quad. of Altitude* come to the *First Merid.* so shall the *Triangle* be made

on.

on the *Globe*: Then the *Arch* of the *Brazen Meridian* comprehended between the *Pole* and the upper end of the *Quadrant of Altitude* shall be the Measure of the *Side AB* 38 Degrees 30 Minutes; and the *Arch* of the *First Meridian* comprehended between the Prick on the *Quadrant of Altitude* and the *Pole* shall be the Measure of the *Side AC* 60 Degrees; But the *Angle C* you must find by Turning the *Triangle*; as in Prob. 7.

In the Working this *Probleme* I would have placed the given *Side BC* 25 Degrees upon the *Brazen Meridian* between the *Pole* and *Zenith*; but then the *Angle B* (being so *Obtuse*) would have had that *Side* which would be intersected by the *Quadrant of Altitude*, (viz. the *First Meridian*) under the *Horizon*, which the *Quadrant of Altitude* cannot reach.

## P R O B. XII.

*Three Angles given, to find the Sides.*

**T**His *Triangle* is taught to be Resolved by Mr. *Palmer* on the *Planisphere*; Book 3. Chap. 19.

It isto be known (saith he) That if you go to the *Poles* of the three Great Circles whereof your *Triangle* is made, these *Poles* shall be the *Angular Points* of a Second *Triangle*; and the two lesser *Sides* of this Second *Triangle* shall be equal to the two lesser *Angles* of your First *Triangle*: the Greatest *Side* of the Second *Triangle* shall be the Supplement of the Greatest *Angle* of the First *Triangle* (that is, shall have as many Deg. and Minutes as the Greatest *Angle* of the First *Triangle* wanted of 180 Degrees) See *Pitiscus Trigonometry Lib. 1. Prob. 61.*

This Second *Triangle* therefore (all whose *Sides* are known from the *Angle* of the First) you shall Resolve by Prob. 7. and having by that *Probleme* found the *Angles* of the Second *Triangle*, know that the two lesser *Angles* of the Second *Triangle* shall be several and respectively equal to the two lesser *Sides* of the First *Triangle* (and the least *Angle* to the least *Side*, the Middle *Angle* to the Middle *Side*) and the Greatest *Angle* of this Second *Triangle* being Subtracted out of 180 Degrees shall leave you the Greatest *Side* of your First *Triangle*.

**E**xample. If the *Angles* be given 142 Degrees 42 Minutes, 17 Degrees 15 Minutes, and 25 Degrees 24 Minutes; and the

C c 2

Sides

*Sides* be enquired. Draw by aim a rude Scheme of this First Triangle, writing in the *Angle A* 17 Degrees 15 Minutes, in *B* 142 Degrees 42 Minutes, in *C* 25 Degrees 24 Minutes; supposing the *Sides* yet unknown: then draw under this by aim also, a Scheme of the Second Triangle, setting his *Base* Parallel with the *Base* of the First, and making the *Base* of the Second shorter than the *Base* of the First. Set also *B* at the *Vertical Angle*, and *A C* at the *Base*; as in the First Triangle. Then say,

Because *A* in the First Triangle is 17 Deg. 15 Minutes, therefore in the Second Triangle *B C* (which *Subtendeth A*) shall be 17 Degrees 15 Minutes: and because *C* in the First Triangle is 25 Degrees 24 Minutes, therefore in the Second Triangle the *Side A B* (which *subtendeth C*) shall be 25 Degrees 24 Minutes; and because *B* the Greatest *Angle* in the First Triangle, is 142 Deg. 42 Minutes, therefore in the Second Triangle the *Side A C* (which *Subtendeth B*) shall be the Complement thereof to 180 Degrees, viz. 37 Deg. 18 Minutes: Write now upon the *Sides* of this Second Triangle the Quantities of the *Sides*, so is your Second Triangle ready to be Resolved, as by Prob. 7. whereby you shall find the *Angles* of the Second Triangle, as I have expressed them in the Scheme; *A* 25 Degrees, *C* 38 Degrees 30 Minutes, *B* 120 Degrees.

Now lastly, I say these *Angles* of the Second Triangle thus found; give me the *Sides* of the First Triangle, which I seek, in this manner.

In the Second Triangle.

*A* is 25 Degrees.

*C* is 38. 30.

*B* is 120. 00.

Thus by all the *Angles* given, we have found out all the *Sides*; which was required.

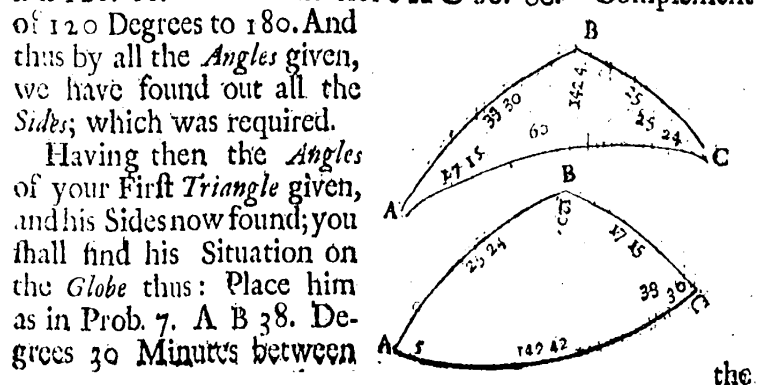
Having then the *Angles* of your First Triangle given, and his *Sides* now found; you shall find his Situation on the *Globe* thus: Place him as in Prob. 7. *A B* 38. Degrees 30 Minutes between

In the First Triangle.

*B C* is 25 Degrees.

*A B* 38. 30.

Therefore *A C* 60. 00. Complement



the

the Pole and Zenith, *A C* 60 Degrees in the First Meridian separated from the Brazen Meridian 17 Degrees 15 Minutes of the Equinoctial, *B C* 25 Degrees on the Quadrant of Altitude counted from the Zenith when its lower end is applied to 142 Deg. 42 Minutes of the Horizon: you shall say, because the East Point of the Horizon is the Pole of the Arch *A B*, therefore at the East Point of the Horizon shall stand the *Angle C*, which *AB* *Subtendeth*: Then number from the Quadrant of Altitude 90 Deg. on the Horizon Eastwards, and there is the Pole of the Arch *B C*: Therefore there shall stand the *Angle A*, which *BC* *Subtendeth*. These 90 Deg. will end at 37 Deg. 18 Min. counted from the East Point of the Horizon Northwards: then Count in the Equator from the First Meridian 90 Deg. which will end under the Horizon, and there make a Prick; for there is the Pole of the Arch or Side *A C*. Therefore at that Prick shall stand the *Angle B* which *A C* *Subtendeth*.

Here you see your Second Triangle made by the Poles of the First, adjoining to the East Point of the Globe; only the Side *A B* is wanting: To get that, make a Prick upon the Globe against the 37 Deg. 18 Min. from the East Point of the Horiz. Northwards found before, to represent the *Angle A*: Then turn about the Globe and Quadrant of Altitude till that Prick and the Prick made before for the *Angle B* are both at once Cut by the Side of the Quadrant of Altitude, and you will find 25 Deg. 24 Min. of the Quadrant of Altitude comprehended between the two Pricks, for the Measure of the Side *A B*.

### PROB. XIII.

*How to Let fall a Perpendicular that shall divide any Oblique Spherical Triangle into two Right Angled Spherical Triangles.*

THIS Problem is much used when an Oblique Triangle having two *Sides* and an *Angle* given is to be Solved by the Cannon of Sines and Tangents: but by the Globe it may be Solved without it, as was shewed Prob. 8, 9. Yet because Letting fall a Perpendicular is so frequent in all Authors that treat of Trigonometry, I have inserted this Problem also.

In

In the *Oblique Triangle*  
of the former Problems  
there is given the *Sides* AB

$38\frac{1}{2}$  Degrees, and BC 25

Degrees and the *Angle* C

25 Degrees 24 Minutes; It

is required to Let fall a *Perpendicular* as Ba from the *Angle* B,  
upon the *Base* AC; and to know both the Measure of this  
*Perpendicular*, and the parts it divides the *Base* into.

Therefore Elevate the *Pole* of the *Globe* above the *Horizon*  
so much as is the Measure of the *Angle* C, which in this *Example*  
is 25 Degrees 24 Minutes, and bring the intersection of the  
*First Merid.* with the *Equinoctial* to the *East* Point in the *Horiz.*  
so shall the *Angle* at the *East* Point of the *Horiz.* comprehen-  
ded between the *Horiz.* and the *First Merid.* be equal to the  
*Angle* C: then Count in the *First Merid.* from the *East* point of  
the *Horiz.* the Measure of the *Side* BC 25 Degrees; and hav-  
ing the *Quadrant of Altitude* screwed to the *Zenith*, bring the  
Graduated edge of it to these 25 Degrees, so shall the *Arch* of  
the *Horiz.* comprehended between the *East* Point and the  
lower end of the *Quadrant of Altitude* be the number of Deg.  
that the *Perpendicular* Falls upon the *Base*, counted from the  
*Angle* C to a which in this *Example* is  $21\frac{1}{4}$  Deg. and the *Arch*  
of the *Quad. of Altitude* comprehended between the *Horiz.* and  
the *First Merid.* is the Measure of the *Perpendicular* Ba 11 Deg.

And thus by Letting fall this *Perpendicular* you have two  
*Right Angled Spherical Triangles* made, the one B a C, wherein is  
found C a  $21\frac{1}{4}$  Deg. BC 25 Deg. Ba 11 Degrees, C 25 Degrees  
24 Minutes, and a the *Right Angle*: There remains only the  
*Angle* B unknown; which you must find by Turning the *Trian-*  
*gle*, as was taught Prob. 1. The Other *Right Angled Spherical*  
*Triangle* made, is Ba A, wherein is found A a, Complement  
of  $21\frac{1}{4}$  Degrees to 60 Degrees (the whole *Base* before given)  
 $38\frac{1}{2}$  Degrees, AB 38 Degrees 30 Minutes, Ba 11 Degrees,  
and a the *Right Angle*; which is more than enough to find the  
*Angles* A and B; as was shewed in the *Preface Theorem* 1.

The End of the Sixth Book.

AN

A N.

## APPENDIX,

Shewing the

EXPLANATION and USE

OF THE

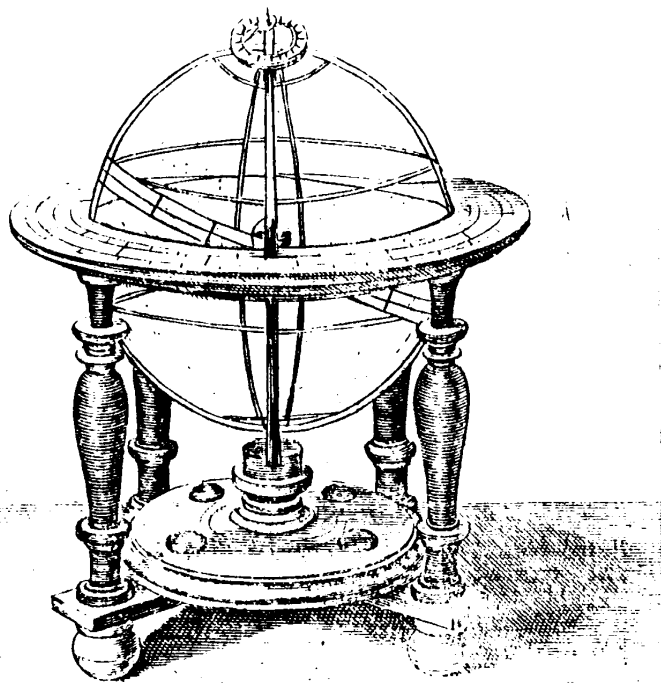
# PTOLOMAICK SPHERE.

## P R Æ F A C E.

HAVING for some time past Made and Sold Ptolomaick Spheres, I have found some of my Customers much desirous of something that might instruct them in the Use of them; And to comply with their Desires, I have publisht this Appendix; which though it be small, yet considering what hath been taught of the Use of the Globes, it is copious enough for the Use of the Ptolomaick Sphere: For the Globe and Sphere are Instruments of so near a Kin, that Readers of Astronomy many times indifferently Name either the one or the other for the same purpose.

There hath indeed a Book been publisht of the Use of the Ptolomaick Sphere; but the Sphere that Book was made for, differs from the Spheres Vulgarly made: for that

that Sphere was purposely made for Prince Henry, eldest Son to King James of blessed Memory, and no cost spared to make it either Useful or Beautiful; as may yet be seen by the Instrument it self; it being lately in the possession of Sir Jonas More in the Tower of London, and therefore would be too dear for general Sale. But the Spheres for which this Appendix is designed, is the Common Ptolomaick Sphere, by which Sphere after a Practitioner grows a little familiar with the constitution of the Heavens, he may sufficiently conceive how the Zodiacal and Elliptical motions of the Planets are made: and also in what Places of their several Orbs their Perigeums and Apogeums will fall out.



### What a Sphere is.

I Told you in the first Chapter of the first Book, that a *Globe* according to the *Mathematical* definition is a perfect and exact round Body contained under one Surface. The definition of a *Sphere* is the same. So then, the *Globe* and *Sphere* as they are *Geometrick* Bodies are also the same. Yet, as they are *Astronomical* Instruments there is a difference in them: For as a *Sphere* is an *Astronomical* Instrument, it is a complication of material Circles only, so fitted together that they represent all the Imaginary Circles and Motions of the Eighth *Sphere*, and the Circles and Motions of all the *Planets* about the *Earth*. Therefore on this material *Sphere* you can neither have all the *Constellations* and *Stars*, nor the shape of the *Earth*, *Waters*, *Towns*, &c. depicted: because of the vacuities between the several Circles. Yet is the *Sphere* applicable to almost all the *Astronomical* Uses the *Celestial* and *Terrestrial* *Globes* are: And in some cases more apt to represent the Order and Appearance of the *Planetary* Orbs. For thereon have you represented the *Zodiack*, the *Equinoctial*, the *Colures*, the *Tropicks*, the *Polar* Circles, the *Meridian*, the *Horizon*, *Verticle Circle*, *Hour-Circle*, &c. just in the same manner and order they are on the *Celestial* and *Terrestrial* *Globe*; and therefore I refer you to the several Definitions in the first Book: Only with this difference, that where you find *Globe* you read *Sphere*.

And as the Circles of the *Globe* and *Sphere* are the same, so is the manner of working with the *Globe* and *Sphere* the same; and the Precepts you find in the several Problems throughout this Book that relate only to the Circles you find in the *Sphere*, serve indifferently and in the same manner for the *Sphere*, it (as was said) you only read *Sphere* where you find *Globe*. This I shall pass by without farther enlarging on, because it is so plain: and shall come to shew you in what respect a *Sphere* is more apt to represent the Order and Appearance of the *Planetary* Orbs than a *Globe* is. And that is, because a *Sphere* is complicated only of Iath-like Circles to represent each Orb, and is not an intire Orb as a *Globe* is, so that you may see the several Fabrications that are made within it. But if the *Sphere* were made of intire Orbs you could see only the outmost Orb, not any of the inner Fa-

D d      brications:

cations: as we may see in an *Onyon*, which though it be made up of several *Orbs* the one within another, as the whole *World* is of many *Heavens* or *Orbs* one within another: yet can we only see the utmost *Orb* or *Scale* of the *Onyon*, that wrapping up and hiding all the other from our *Eys*. So that all the *Orbs* (as we must call them) of the *Sphere* are not real *Orbs*, but serve only for the representation of *Orbs*.

Besides, you have every *Planet* represented in an *Orb* by it self, and that in the same Order that it is ranked in in Heaven.

As First The outmost *Orb* of all, which represents the *Orb* of the Eighth *Heaven*, or *Starry Heaven*, consists of the two *Colures*, which are those two great Circles that cross each other at Right Angles in the *Poles* of the *World*, and are divided from the *Equinoctial* each way into 90 Degrees, and numbred with numerical Figures from the *Equinoctial* towards either *Pole* with 10, 20, 30, to 90.

Secondly, The *Equinoctial*, which is a Circle lies exactly in the middle between the two *Poles*, and Cuts the *Colures* at Right Angles, as it is also Cut by them. It is divided into 360 Degrees numbred from the *Vernal Colure Eastwards*, with 10, 20, 30, to 30 60.

Thirdly, The *Zodiack*, which is a broad Circle that lies Oblique or aslope from the *Equinoctial*, making an *Angle* of  $23\frac{1}{2}$  Degrees with it. It is Cut by the *Equinoctial* and its *Colures* in two Points, viz. in  $\Upsilon$  and  $\varpi$ , and by the *Tropical Colure* in two Points, viz. in  $\odot$  and  $\oslash$ . In the middle of this broad Circle lies the *Ecliptick* Line, which is divided into twelve equal Parts, called *Signs*, as *Aries*, *Taurus*, *Gemini*, &c. to *Pisces*, and ornamented with the Picture of each *Sign*, as to  $\Upsilon$  you have the Picture of a Ram, to  $\odot$  a Bull, and so of the rest. Each *Sign* is again divided into 30 Degrees, and numbred from the beginning of the *Sign* towards the end with 10, 20, to 30. It hath about 5 Degrees of breadth on either side the *Ecliptick*, for the Swerving of the *Planets* from the true *Ecliptick* Line.

Fourthly, The two *Tropicks* are smaller Circles, commonly made of Wye, that Decline  $23\frac{1}{2}$  Degrees from either side the *Equinoctial*, and therefore bound the *Ecliptick*. They Cut the *Colures* at Right Angles, as also they are Cut by the *Colures*.

Fifthly, The *Arctick* and *Antarctick* Circles, are two Circles yet smaller than the *Tropicks*, also made of Wye, that Decline

$23\frac{1}{2}$  De-

$23\frac{1}{2}$  Degrees from either *Pole*: These also Cut the *Colures* at Right Angles, as they are also Cut by the *Colures*.

This Machine is called the Eighth *Heaven*, Because it serves to represent the Eighth *Heaven*: But its Motion is performed upon its two *Poles*, through which runs a straight Wye, to represent the *Axis* of the *World*, and therefore is called the *Axis*: Next within the Eighth *Heaven*, is placed the *Sphere* or *Heaven* of *Saturn*. It is represented by three Circles: Two of them Cut each other at Right Angles in their *Poles*, even as the *Colures* do. But for distinction from the *Colures* shall be called Upright-Circles when ever I name them with relation to the *Sphere* of any of the *Planets*: The other Circle Cuts these Upright Circles, and is also Cut by them at Right Angles in the middle between their two *Poles*: as the *Equinoctial* does the *Colures*: which Circle I shall hereafter call the Flat Circle, when I name it with relation to the *Sphere* of any of the *Planets*: on this Circle is writ *Sphera Saturni*: and hard by it is fitted on one of the Upright Circles, a Brass plate with a Button on it, which button represents the *Star* or *Planet*  $\S$  it self: it is made to slide Northwards or Southwards on the Upright Circle, because  $\S$  oft Alters its *Latitude* from the *Ecliptick*, and consequently its *Declination*: And by this means you may slide it to any *Latitude*, or *Declination* you shall see cause for.

Next within the *Sphere* of *Saturn*, is placed the *Sphere* of *Jupiter*, which is represented by such Circles, and a sliding Button, even as the *Sphere* of *Saturn* is.

Next within the *Sphere* of  $\mu$ , is placed the *Sphere* of  $\delta$ , within the *Sphere* of  $\delta$ , the *Sphere* of  $\zeta$ , within the *Sphere* of  $\zeta$ , the *Sphere* of  $\eta$ , within the *Sphere* of  $\eta$ , the *Sphere* of  $\theta$ , within the *Sphere* of  $\theta$ , the *Sphere* of  $\iota$ , all represented as is the *Sphere* of  $\S$ , and all performing their Motions upon their own *Poles*, and the *Axis* of the *World*.

Within the *Sphere* of  $\alpha$ , is placed a small *Globe* of the *Earth*, whereon is described all the *Countries* of the *Earth*, and the Names of so many inserted as the Magnitude of that *Globe* is conveniently able to receive.

This Ball is fixed in the Middle of all the *Heavens*, and about it, as about a common Center, they all Perform their various Motions.

This Machine, or Fabrick, or Model of the Visible *World*,  
D d 2 (which

(which you will) is Hung in a *Brasen Meridian*, as a *Globe* is See § 4. of Chap. 1. Book 1. And this *Meridian* is let into a *Wooden Horizon* as in § 5. of the same Chap. and Book.

The *Quadrant of Altitude*, *Hour-Circle*, and its *Index*, *Nautical Compass*, and *Semi-Circle of Position*, which belong to a *Sphere*, are in all respects the same with those belonging to a *Globe*, and therefore I refer you to § 6, 7, 8, 9. of the same Chapter.

But because all Problemes that have relation to any of the *Planets*, or their *Spheres*, are more aptly and properly performed by the *Sphere* than the *Globe* (because you have a particular *Heaven* assigned each particular *Planet*, and by reason of the openness of every *Sphere* you may see the more natural Situation and position of them all at once.) Therefore I here produce two Problemes which may serve as *Examples* to direct you in all Operations, that you may meet with of this Nature. And first,

#### PROB. V.

*To Set the Sphere and all the Planets in a Position agreeable to the whole Frame of the Visible World, at any given Time.*

First Rectifie the *Eighth Sphere*, *Horizon*, *Quadrant of Altitude*, and *Hour Index* to your Elected Time. Then by an *Ephemeris* find the true Places of the *Planets* in *Heaven* for that Time: and bring each respective *Node* which represents each respective *Planet*, to those several Places you find them in the *Ephemeris*; so shall the *Planets* appear in the *Sphere* just in the same Place they are in *Heaven*.

#### Example.

I would Place the *Planets* on the *Sphere* to Agree with the Places they have at this present Time, viz. 1669. Sep. 17. just at Noon, in the Latitude of  $51\frac{1}{2}$  Degrees. Therefore I first Rectifie the *Sphere* to the given Time, as by Prob. 2. of the 2d. Book, then in the *Ephemeris* I find the Place of the *Sun*  $\approx 4$  Degrees 42 Minutes, Therefore I bring the little *Golden Node* on the

*Suns*

*Suns Orb* to  $\approx 4$  Degrees 42 Minutes, so is that little *Golden Node* Placed in the *Sphere* to agree with the Place the *Sun* hath in *Heaven*: then searching the *Ephemeris* again for the *Moons* Place, I find She is in  $110$  Degrees 36 Min. and hath 10 Minutes *North Latitude* from the *Ecliptic*. Therefore I bring the little *Silvered*  $\alpha$  in the *Moons Orb*, to  $110$  Degrees 36 Minutes of the *Eighth Sphere*, and slide the *Silver*  $\alpha$  10 Minutes to the *Northwards* of the *Ecliptick Line*, so is that *Silvered Moon* Placed in the *Sphere* to agree with the Place the *Moon* hath in *Heaven*. Then searching in the *Ephemeris* for the place of  $h$ , I find  $h$  in 19 Degrees 19 Minutes of  $\approx$ , and hath 1 Deg. 27 Min. *South Latitude* from the *Ecliptick*: therefore I bring the little *Node* or *Ball* upon the *Sphere* of  $h$ , to  $\approx 19$  Degrees 19 Minutes of the *Eighth Sphere*, and slide the *Button* or *Node* which represents  $h$  1 Deg. 27 Min. to the *Southwards* of the *Ecliptick Line*: so is that *Node* or *Ball* Placed in the *Sphere* to agree with the place  $h$  hath in *Heaven*. The like way I use, to place  $\gamma, \delta, \epsilon, \zeta$ , in the *Sphere* to agree with their Places in *Heaven*.

The *Eighth Sphere* and the *Nodes* representing all the *Planets*, being thus posited, becomes an actual Representation of the whole Frame of the *Visible World*: and all the *Spheres* of the *Planets* by being turned about with the *Eighth Heaven*, perform a *Diurnal* Mutation, and shew all the Various Appearances they will have in *Heaven*, for that Day, viz. The Time of their Rising and Setting, as by Prob. 7, 8. Their *Altitudes* as by Prob. 6. Their *Amplitudes* as by Prob. 10. Their *Azimuths* and *Almicanters* as by Prob. 22, 23. Their *Right Ascensions* as by Prob. 26. Their *Declinations* as by Prob. 2. Their *Oblique Ascensions* and *Oblique Descensions* as by Prob. 28. Their *Diurnal* and *Nocturnal Arches* as by Prob. 38. of the Second Book: Their *Configurations* or *Aspects* among Themselves, and their *Circulations* about the *Earth*.

#### PROB. II.

*How Eclipses are Demonstrated by the Sphere.*

YOU must know that the *Moon* moves not constantly in the *Ecliptick*, as the *Sun* does, for if She did, there would two *Eclipses* happen every month; the one of the *Sun*, and the other of the *Moon*, but She Moves in a Circle



Circle Oblique to the *Ecliptick* about 5 Deg. even as the *Ecliptick* is Oblique to the *Equinoctial*  $23\frac{1}{2}$  Deg. And as the *Ecliptick* Cuts the *Equinoctial* only in two Opposite points, viz.  $\gamma$  and  $\pi$ ; So the Circle of the *Moon* Cuts the *Ecliptick* only in two Opposite Points, which are called, The *Dragons-Head* (thus character'd  $\Omega$ ) and the *Dragons Tail* (thus character'd  $\varpi$ ) That point which intersects the *Ecliptick* on the *Eastern* side, and proceeds *Northwards*, is called the *Dragons-Head*; and the Opposite Point the *Dragons-Tail*. These Points constantly shift their Places, and have a *Retrograde* Motion through the *Ecliptick* in almost 19 Years: And when the *Sun* and *Moon* meet in or near either of these Points, or oppose each other in or near these Points, an *Eclipse* happens; If they meet, the *Sun* is *Eclipsed*, because the Dark solid Body of the *Moon*, interposes between our Sight and the *Sun*, and so hides him: If they Oppose each other, the *Moon* is *Eclipsed*, for then the Dark solid Body of the *Earth*, interposes between the *Sun* and the *Moon*, and so hinders the Light of the *Sun* from falling upon the *Moon*, which hath no Light of Her own but what She receives from the *Sun*.

But that you may the more plainly see the Demonstration of *Eclipses* by the *Sphere*: Place the Golden Ball representing the *Sun*, and the Silvered  $\odot$  representing the  $\odot$  in two Opposite Points of the *Ecliptick*; so shall the *Sun*, the *Earth*, and the *Moon* be all in a straight Line, and the *Moon* *Eclipsed*, because the *Earth* lying directly between the *Sun* and the *Moon*, keeps the Light of the *Sun* off the *Moon*, and so becomes a Shadow to Her, which of Her self hath no Light but what she receives from the *Sun*, as was said before; and the *Moon* will continue Darkned, till She comes out of the *Earth's* Shadow.

Again, Place the *Sun* and *Moon* in the same Sign and Deg. of the *Ecliptick*; and imagine as before, a Light to come from the *Sun* in the *Sphere*; then will you see the Reason why the light of the *Sun* cannot fall upon the *Earth*, viz. Because the *Moon* is interposed betwixt the *Sun* and the *Earth*, and so Shadows the *Earth* by keeping the Light of the *Sun* off it, which to us appears as if the *Sun* were Darkned, though indeed it is only the *Earth* that is deprived of the *Sun's* Light by the interposition of the *Moon*, as aforesaid.

But because an *Eclipse* happens not, as was said before, but when the *Sun* and *Moon* seem to meet or oppose one another in

or near the *Dragons-Head* or *Tail*; therefore by the following Rule you must learn to find the Place of the *Dragons-Head* and *Tail*, that so by the *Sun's* and *Moons* Progress through the *Ecliptick*, you may know when the *Sun* and She will Meet or Oppose each other in or near those Points, and accordingly fore-know an *Eclipse*.

### How to find the place of the Dragons-Head and Tail.

The *Dragons-Head* and *Tail* finish a *Retrograde Revolution* through the *Ecliptick* in 18 Years 224 Days and 3 Hours; So that in one Year it Moves 19 Deg. and 20 Min. in a month 1 Deg. 36 Min. and in one Day 3 Min. Therefore if for any Time Past or to Come, you know the Place of the *Dragons-Head* or *Tail* you may Add or Subtract 19 Deg. 20 Min. for every Year, 1 Deg. 36 Min. for every Month, and 3 Min. for every Day, and the Remainder shall be the Deg. and Min. that the *Dragons-Head* or *Tail* is in.

### Example.

It is to be supposed that I remember the Place of the *Dragons Head* to be in  $\varpi$  12 Deg. 20 Min. I would know the Place of the *Dragons-Head* for this present Day, Sept. 17. 1669. Since January 1. 1663. there is 6 Years 8 Months and 17 Days past: Therefore for each Year I allow 19 Deg. 20 Min. which makes 116 Deg. for the 8 Months I allow 8 Deg. and 8 times 36 min. viz. 12 Deg. 48 Min. more, which makes 128 Deg. 48 Min. and for the 17 Days I allow 5 min. which,

116---00

12---48

51 added together, make

129 Deg. 39 min.

which subtracted (because the *Dragons-Head* Moves contrary to the Succession of Signs) from  $\varpi$  12 Deg. 20 Min. leaves 8 two Deg. 41 Min. for the Place of the *Dragons-Head* Sept. 17. 1669. The Place of the *Dragons-Tail*, as was said before, is the Deg. and Min. of the *Ecliptick* Opposite to that of the *Dragons-Head*, which in this Example is  $\Omega$  2 Deg. 41 Min.

Here

Here follows the

## A N C I E N T S T O R I E S

Of the several

### S T A R S and C O N S T E L L A T I O N S.

Shewing the Poetical Reasons why such Various  
Figures are placed in *H E A V E N*.

*Collected from Dr. Hood.*

And first,

*Of the Nothern Constellations.*

**U**RSA MINOR. This *Constellation* hath the Preheminence, because it is nearest of all the rest unto the *North Pole*; And is called of the *Greeks Arctos*, whereupon the *Pole* is called the *Pole Artick*, for that it is near unto that *Constellation*. It is also called *Helice Minor*, because of the small Revolution which it maketh round about the *Pole*: or rather of *Elice*, a Town in *Arcadia*, wherein *Calisto* the Great Bear, and Mother to the less, was bred. It is called *Cynosura*, because this *Constellation*, though it carry the name of a Bear, yet it hath the Tail of a Dog: Last of all, it is termed *Phenice*, because that *Thales*, who first gave the name to this *Constellation*, was a *Phœnician*: And therefore the *Phœnicians* being taught how to use it in their *Navigations*, did call it by the name of the Country wherein *Thales* was born. It consisteth of seven Stars, which the Latines call *Septentriones*; because by their continual Motion those seven Stars do as it were wear the *Heavens*. The *Spaniards* call them all *Bosina*, that is an *Horn*; because they may be Very well brought into that Form; whereof that which is in the end of the Tail, is called the *Pole-star*, by reason of the nearness thereof unto the *Pole* of the *World*: for it is distant (according to the opinion of most) from the true *Pole*, but 3 Degrees 30 Minutes. The *Arabians* call

call it *Alrukaba*: And of the *Scythians* it is said to be an *Iron nail*, and is Worshipped by them as a God. The two Stars that are in the shoulders of the Bear, are called the *Guards*, of the *Spanish* word *Guardare*, which is to behold; because they are diligently to be looked unto, in regard of their singular Use which they have in Navigation.

The reason why this *Constellation* was brought into the *Heavens* is diversly set down, and first in this manner: *Saturn* having received of the Oracle that one of his Sons should banish him out of his Kingdom, determined with himself to kill all the men children that he should beget: whereupon he gave command to *Ops* his wife, being then great, that she should shew him Child so soon as ever it was born: But she bringing forth *Jupiter*, and being greatly delighted with his hair, gave the Child unto two Nymphs of *Crete*, dwelling in the mount *Dicte*; whereof this was one, and was called *Cynosura*, the other was *Helice*.

*Jupiter*, after that (according to the Oracle) he had bereft his Father of his Kingdom, in recompence of their pains and courtesie, translated them both into the *Heavens*, and made of them two *Constellations*: the *Lesser Bear*, and the *Greater Bear*.

Other some say that it was *Arcas* the Son of *Calisto*, and they tell the Tale on this manner: *Calisto* a Nymph of singular beauty, Daughter to *Lycaon* King of *Arcadia*, induced by the great desire she had of Hunting, became a follower of the Goddess *Diana*. After this, *Jupiter* being enamored with her Beauty, and out of hope, by reason of her profession to win her Love in his own Person, counterfeited the shape of *Diana*, Lay with *Calisto*, and got her with Child, of whom was born a Son, which was called *Arcas*. *Diana*, or rather *Juno*, being very much offended herewith, turned *Calisto* into a Bear: *Arcas* her Son at the Age of fifteen, Hunting in the Woods by chance lighted upon his Mother in the shape of a Bear: who knowing her Son *Arcas*, stood still that he might come near unto her, and not be afraid: but he fearing the shape of so cruel a Beast, bent his Bow of purpose to have slain her: whereupon *Jupiter* to prevent the mischief translated them both into *Heaven*, and of them made two several *Constellations*: unto the *Lesser Bear*, there belongs but one Star: unformed.

2. **URSA MAJOR**, the *Greater Bear*, called also of the *Greeks Arctos*, and *Helice*, consisteth of twenty seven Stars: Among the

the

which

which, those seven that are in the Hinder part and Tail of the Bear, are most observed; the *Latins* call them *Plaustrum*; and of our Men they are called *Charles Wain*; because the *Stars* do stand in such sort, that the three which are in the Tail resemble the Horses, and the other four which are in the flank of the Bear, stand (after a manner) like the Wheels of a Wagon, or Chariot; and they are supposed by some to be greater than the *Sun*. The reason of the Translation of this *Constellation* into the *Heaven*, is at large set down in the other *Constellation*, and therefore needs not here to be repeated. This *Constellation* was first invented by *Nauplius*, the Father of *Palamedes* the Greek: and in great use among the *Grecians*; and this is to be noted both in this and the former *Constellation*, that they never Set under the *Horizon* in any part of *Europe*: which though it fall out by reason of their Situation in the *Heavens*; yet the Poets say, that it came to pass through the displeasure and hatred of *Juno*; who for that she was by *Calisto* made a Cuckquean, and they notwithstanding (as she took it) in despite of her were translated into *Heaven*, requested her Brother *Neptune*, that he should never suffer those *Stars* to Set within his Kingdom. To which request *Neptune* condescended; so that in all *Europe* they never come near unto the Sea, or touch the *Horizon*. If any one marvel, that (seeing she hath the form of a Bear) she should have a Tail so Long; Imagine that *Jupiter* fearing to come too nigh unto her Tee: h, laid hold on her Tail; and thereby drew her up into *Heaven*; so that she of her self being very weighty, and the distance from the *Earth* to the *Heaven* very great, there was great likelihood that her Tail must stretch. The Unformed *Stars* belonging to this *Constellation* are eight.

3. DRACO, the Dragon, of some named the *Serpent*; of others the *Snake*, by the *Arabians*, *Aben*; and by *Junctinus Florentinus* *Urago*; because he windeth his tail round about the *Ecliptick Pole*; it containeth one and thirty *Stars*. This was the Dragon that kept the Golden Apples in the Orchard of the *Hesperides*, (now thought to be the Islands of *Cape de Virde*) and for his diligence & watchfulness, was afterwards translated into *Heaven*. Yet others say that he came into *Heaven* by this occasion; when *Minerva* withstood the *Gyants* fighting against the *Gods*; they to terrifie her threw at her a mighty Dragon; but she catching him in her Hands, threw him presently up into *Heaven*.

*Heaven* and placed him there, as a Memorial of that her resistance. Others would have it to be the *Serpent Python*, whom *Apollo* slew, after the Deluge.

4. CEPHEUS containeth in him eleven *Stars*, and hath two unformed. This was a King of the *Ethiopians*, and Husband unto *Cassiopeia*, and Father of *Andromeda*, whom *Perseus* married. He was taken up into *Heaven*, with his Wife and Daughter, for the good deeds of *Perseus* his Son in Law; that he and his whole Stock might be had in remembrance for ever. The *Star* which is in his Right Shoulder, is called by the *Arabians* *Alderabiemin* (i. e.) his Right Arm.

5. BOOTES, the Driver of the Oxen (for so I suppose the name to signify, rather than an Herdsman; for he hath not his name because he hath the care of any Cattel, but only because he is supposed to drive *Charles his Wain*, which is drawn by three Oxen) He is also called *Arctophilan*, the keeper of the Bear, as though the care of Her were committed to him: This *Constellation* consisteth of two and twenty *Stars*. Some will have *Bootes* to be *Arcas*, the Son of her who before was turned into the Great Bear; and they tell the Tale thus: *Lycaon* the Father of *Calisto*, receiving *Jupiter* into his House as a Guest, took *Arcas* his Daughters Son, and cut him in pieces; and among other Services, set him before *Jupiter* to be eaten: for by this means he thought to prove if his Guest were a God, as he pretended to be. *Jupiter* perceiving this heinous fact, overthrew the Table, fired the House with Lightning, and turned *Lycaon* into a Wolf: but Gathering, and setting together again the Limbs of the Child, he committed him to a Nymph of *Atolia* to be kept: *Arcas* afterwards coming to Mans estate, and hunting the Woods, lighted at un-awares upon his Mother, transformed by *Juno* into the shape of a Bear, whom he pursued into the Temple of *Jupiter* *Lycaon*, whereunto by the Law of the *Arcadians*, it was death for any man to come. For as much therefore as they must of likelihood be both slain, *Calisto* by her Son, and he by the Law; *Jupiter* to avoid this mischief, of meer pity took them both up into *Heaven*. Unto this *Constellation* belongeth but one *Star* unformed, and it is between the Legs of *Bootes*, and by the *Grecians* it is called *Arcturus*, because of all the *Stars* near the Great Bear named *Arctos*, this *Star* is first seen near her Tail in the Evening. The Poetical invention is thus.

*Icarus* the Father of *Erigone*, having received of the *Cod*  
E e 2 *Bacchus*

*Bacchus* a Flagon of Wine, to declare how good it was for mortal Men, travelled therewith into the Territories of *Athens*, and there began to carouse with certain Shepherds; they being greatly delighted with the pleasantness of the Wine, being a new kind of Liquor, began to draw so hard at it, that ere they left off, they were past one and thirty; and in the end, were fain to lay their Heads to rest. But coming unto themselves again and finding their Brains scarce in good temper, they killed *Icarus*, thinking indeed that he had either Poysoned them, or at the leastwise made their Brains intoxicate. *Erigone* was ready to die for grief, and so was *Mera*, her little Dog. But *Jupiter* to allay their grief, placed her Father in Heaven, between the Legs of *Arctophilax*.

6. CORONA BOREA, the Northern Garland, consisteth of Eight Stars; yet *Ovid* saith, that it hath Nine. This was the Garland that *Venus* gave unto *Ariadne*, when she was married unto *Bacchus*, in the Isle *Naxos*, after that *Theseus* had forsaken her: which Garland, *Bacchus* placed in the Heaven, as a token of his love. *Nevidius* will have it to be the Crown of the Virgin *Mary*.

7. ENGONASIS: This Constellation hath the name, because it is expressed under the shape of a man kneeling upon the one Knee, and is therefore by the Latines called *Ingeniculum*. It containeth nine and twenty Stars, and wanteth a proper Name, because of the great diversity of Opinions concerning the same. For some will have it to be *Hercules*, that mighty Conqueror, who for his 12 labours was thought worthy to be placed in Heaven, and nigh unto the *Dragon* whom he overcame. Others tell the Tale thus: That when the *Tytans* fought against the Gods, they for fear of the *Gyants*, ran all unto the one side of the Heaven: whereupon the Heaven was ready to have fallen, had not *Hercules* together with *Atlas*, set his neck unto it, and stayed the fall: and for his desert, he was placed in Heaven.

8. LYRA, the Harp, it containeth ten Stars; whereof thus goeth the Fable. The River *Nilus* swelling above his Banks, overflowed the Country of *Egypt*; after the Fall whereof there were left in the fields divers kinds of living things, and amongst the rest a *Tortoise*; *Mercury*, after the flesh thereof was consumed, the sinews still remaining, found the same, and striking it, he made it yield a certain sound; whereupon he made an Harp like unto it, having three Strings, and gave it unto *Orpheus* the Son

Son of *Cassiopea*. This Harp was of such excellent Sound, that Trees, Stones, Fowls and wild Beasts are said to follow the sound thereof. After such time therefore that *Orpheus* was slain by the Women of *Thrace*, the Muses by the good leave of *Jupiter*, and at the request of *Apollo*, placed this Harp in Heaven. *Nevidius* will have it to be the Harp of *David*, whereby he pacified the evil Spirit of *Saul*. This Constellation was afterwards called *Kultur Cadens*, the Falling Grype: and *Falco* the Falcon; or *Timpanum* the Timbrel.

9. OLOR, or *Cygnus* the Swan, called of the *Chaldeans* *Adigege*; It hath seventeen Stars: of this Constellation the Poets Fable in this manner. *Jupiter* being overtaken with the Love of *Leda* the Wife of *Tyndarus* King of *Oebalia*, and knowing no honest way to accomplish his Desire, procured *Venus* to turn her self into an Eagle, and himself he turned into the shape of a Swan. Flying therefore from the Eagle, as from his natural enemy, that earnestly pursued him, he lighted of purpose in the Lap of *Leda*, and, as it were, for his more safety, crept into her Bosome. The Woman not knowing who it was under that shape, but holding (as she thought) the Swan fast in her Arms, fell asleep. In the mean while *Jupiter* enjoyed his pleasure; and having obtained that he came for, betook him again unto his Wings; and in memorial of his purpose (attainted under that Form) he placed the Swan among the Stars.

*Ovid* calleth this Constellation *Milvius*, the Kite, and telleth the Tale thus. The Earth being greatly offended with *Jupiter*, because he had driven *Saturn* his Father out of his Kingdom, brought forth a monstrous Bull, which in his hinder parts was like a Serpent; and was afterwards called the Fatal Bull, because the *Destinies* had thus decreed, that whosoever could slay him, and offer up his entrails upon an Altar, should overcome the eternal Gods. *Briareus* that mighty Gyant, and ancient enemy of the Gods overcame the Bull, and was ready to have offered up his entrails according to the decree of the *Destinies*: but *Jupiter* fearing the event, commanded the Fowls of the Air to snatch them away: which although to their power, they endeavoured, yet there was none of them found so forward and apt to that action as the Kite, & for that cause he was accordingly rewarded with a place in Heaven. Some call this Constellation *Avis*, that is, the Bird: others call it *Vultur Volans*, the Flying Grype. It is also called *Gallina*, the Hen. Unto this Constellation do belong two unformed Stars.

10. CASSIOPEIA, She consisteth of thirteen Stars. This was the Wife of *Cepheus*, and the Mother of *Andromeda*, whom *Perseus* married, and for his sake was translated into Heaven, as some write. Others say that her beauty being singular, she waxed so proud, that she preferred her self before the *Nereides*, which were the *Nymphs* of the Sea: for which cause, unto her disgrace and the example of all others that in Pride of their Hearts would advance themselves above their betters, she was placed in the Heaven with her head as it were downwards; so that in the revolution of the Heavens she seemeth to be carried head-long.

11. PERSEUS, he hath six and twenty Stars. This was the Son of *Jupiter*, whom he in the likeness of a Golden Shower begat upon *Danae*, the daughter of *Acrisius*. This *Perseus* coming unto mans estate, and being furnished with the Sword, Hat, and Wings of his Brother *Mercury*, and the Shield of his Sister *Minerva*, was sent by his Foster-Father *Polidectes*, to kill the Monster *Medusa*, whom he slew; and cutting off her Head, carried it away with him. But as he was hasting Homeward; flying in the Air, he espied *Andromeda* the daughter of *Cepheus* and *Cassiopea* for the pride of her Mother, Bound with a Chain unto a Rock, by the Sea side, there to be devoured by a Whale: *Perseus* taking notice and pity of the case, undertook to fight with the Monster, upon condition that *Andromeda* might be his Wife; to be short, he delivered *Andromeda*, Married her, and returning Homeward unto the Isle *Seriphus*, he found there his Grandfather *Acrisius*, whom by mischance and unadvisedly he slew with a Quoit: (or as *Ovid* reporteth) with the terrible sight of the horrible Head of *Medusa*, not knowing that it was his Grandfather: but afterwards understanding whom he had slain, he pined away through extreame sorrow. Whereupon *Jupiter* his Father pitying his Grief, took him up into Heaven, and there placed him in that form wherein he overcame *Medusa*, with the Sword in one Hand, and the Head of *Medusa* in the other, and the Wings of *Mercury* at his Heels. This Constellation because of the Unluckiness thereof is called by *Astrologers* *Cademon* (i.e.) *Unlucky*, and *Unfortunate*. For (as they say) they have Observed it, that whatsoever is Born under this Constellation, having an evil Aspect, shall be stricken with Sword, or lose his Head. *Novidius* saith that it is *David* with *Goliath* his Head in one hand, and his Sword in the other. The unformed Stars belonging unto this Constellation, are three.

12. AU-

12. AURIGA, the Waggoner, or Carter: He consisteth of fourteen Stars: the *Arabians* call him *Alaiot*; the *Greeks* *Henniochus*, (i.e.) a Man holding a Bridle in his Hand, and so is he pictured. *Eratostratus* affirmeth him to be *Eristhonius* King of *Athens*, the Son of *Vulcan*, who having most deformed Feet, devised first the use of the Waggon or Chariot, and joyned Horses together to draw the same, to the end that he sitting therein, might the better conceal his deformities. For which invention, *Jupiter* translated him into the Heavens.

In this Constellation there are two other particular Constellations to be noted; whereof the one consisteth but of one Star alone, which is in the left Shoulder of *Auriga*, and is called *Hircus*, or *Capra* the Goat; the *Arabians* call it *Albajoth*: The other consisteth of two little Stars a little beneath the other, standing as it were in the hand of *Auriga*; This Constellation is called *Hædi*, the Kids. The Tale is thus; *Saturn* (as you heard before) had received of the Oracle, that one of his Sons should put him out of his Kingdom, whereupon he determined to devour them all: *Ops* by stealth conveyed away *Jupiter*, and sent him to *Melissus* King of *Crete*, to be nourished: *Melissus* having two Daughters, *Amalthea* and *Melissa*, committed *Jupiter* unto their Nursery; *Amalthea* had a Goat that gave Suck unto two Kids, so that by the Milk of this Goat, she nourished *Jupiter* very well. To requite this her care and courtesie, *Jupiter* (after he had put his Father out of his Kingdom) translated her Goat and her two Kids into Heaven; and in remembrance of the Nurse, the Goat is called *Capra Amalthea*. *Novidius* saith, that when Christ was born, and his birth made manifest by the Angels unto the Shepherds, one of them brought with him for a Present, a Goat and two young Kids; which in token of his good will, were placed in Heaven.

13. OPHIUCHUS, or SERPENTARIUS, That is, the Serpent-bearer. This Constellation hath no proper name, but is thus entituled, because he holdeth a Serpent in his Hands. It containeth four and twenty Stars. Some say that it is *Hercules*, and report the Tale on this manner: *Juno* being a great enemy to *Hercules*, sent two Snakes to kill him as he lay sleeping in his Cradle: but *Hercules* being a lusty Child (for *Jupiter* had spent two daies in begetting him) without much ado strangled them both: In memorial of so strange an event, *Jupiter* placed him in the Heavens, with a Serpent in his Hands.

14. SER-

14. *SERPENS*, the *Serpent* of *Ophiuchus*, which consisteth of eighteen *Stars*. Some say that it is one of the *Serpents* that should have slain *Hercules* in his Cradle. *Novidius* saith, it is the *Viper* that bit *Paul* by the hand. Others deliver the Tale in these words: *Glaucus* the Son of *Minos* King of *Crete*, was by misfortune drowned in a Barrel of Honey: *Minos* his father craved the help of *Æsculapius* the Physician: and that he might be driven perforce to help the Child, he shut him up in a secret place, together with the dead Carcass: whiles *Æsculapius* stood in a great maze with himself what were best to be done, upon a sudden there came a *Serpent* creeping towards him; the which *Serpent* he slew with the staff which he had in his hand. After this there came another *Serpent* in, bringing in his mouth a certain herb, which he laid upon the head of the dead *Serpent*, whereby he restored him unto Life again. *Æsculapius* using the same herb, wrought the same effect upon *Glaucus*. Whereupon (after that) *Æsculapius* (whom some affirm to be *Ophiuchus*) was placed in the *Heaven*, and the *Serpent* with him.

15. *SAGITTA*, or *Telum*; the *Arrow* or *Dart*. This was that *Arrow* wherewith *Hercules* slew the *Eagle* or *Grype* that fed upon the Liver of *Prometheus*, being tyed with chains to the top of the mount *Caucasus*, and in memorial of that deed, was translated into *Heaven*. Others will have it to be one of those *Arrows* which *Hercules* at his death gave unto *Philoctetes*, upon which the *Destiny* of *Troy* did depend. The whole *Constellation* containeth five *Stars*.

16. *AQUILA*, the *Eagle*, which is called *Vultur Volans*, the *Flying Grype*: it hath in it nine *Stars*. The Poetical reason of this *Constellation*, is this; *Jupiter* transforming himself into the form of an *Eagle* took *Ganymedes* the *Trojan Boy*, whom he greatly loved up into *Heaven*, and therefore in sign thereof (because by that means he performed his purpose) he placed the figure of the *Eagle* in the *Heaven*. There belong unto this *Constellation* six *Stars* (before time) unformed, but now brought into the *Constellation* of *Antinous*. But whereupon that name should come, I know not, except it were that some Man devised it there to curry favour with the Emperour *Adrian*, who loved one *Antinous Bithynic* so well, that he builded a Temple in his Honour at *Mantineia*.

17. *DOLPHINUS*, the *Dolphin*: It containeth 10 *Stars* yet;

yet *Ovid* in his Second Book *de Fastis*, saith that it hath but nine. Neither did the Ancient *Astronomers* attribute unto it any more, according to the number of the *Muses*; because of all other *Fishes* the *Dolphin* is said to be delighted with Musick. The Tale goeth thus concerning this *Constellation*. When *Neptune* the God of the *Sea* greatly desired to match with *Amphitrite*, she being very modest and shame-faced, hid her self: whereupon he sent many Messengers to seek her out, among whom the *Dolphin* by his good hap, did first find her; and perswaded her also to match with *Neptune*: For which his good and trusty Service, *Neptune* placed him in the *Heavens*.

Others say, that when *Bacchus* had transformed the *Mariners* that would have betrayed him, into *Dolphins*, he placed one of them in *Heaven*, that it might be a Lesson for others to take heed how they carried any one out of his Way, contrary both to his desire, and their own promise. *Novidius* referreth this *Constellation* unto the Fish that saved *Jonas* from drowning.

19. *EQUICULUS*, is the *Little Horse*, and it consisteth of four *Stars*. This *Constellation* is named almost of no Writer, saving *Ptolemy*, and *Alphonsus* who followeth *Ptolemy*, and therefore no certain Tale or History is delivered thereof by what means he came into *Heaven*.

18. *EQUUS ALATUS*, the *Winged Horse*, or *Pegasus*, it containeth twenty *Stars*. This *Horse* was bred of the blood of *Medusa*, after that *Perseus* had cut off her Head, and was afterwards taken and tamed by *Bellerophon*, whiles he drank of the River *Pirene* by *Corinth*, and was used by him in the conquest of *Chimera*: After which Exploit *Bellerophon*, being weary of the Earthly affairs, endeavoured to fly up into *Heaven*. But being amazed in his Flight, by looking down to the *Earth*, he fell from his *Horse*; *Pegasus* notwithstanding continuing his Course (as they feign) entered into *Heaven*, and there obtained a Place among the other *Constellations*.

20. *ANDROMEDA*, she consisteth of three and twenty *Stars*; but one of them is common both unto her and *Pegasus*. This was the Daughter of *Cepheus* and *Cassiopeia*, and the Wife of *Perseus*; the reason why *Minerva*, or *Jupiter* placed her in the *Heavens*, is before exprest. *Novidius* referreth this *Constellation* unto *Alexandria* the *Virgin*, whom *S. George* through the good help of his *Horse* delivered from the *Dragon*.

F f

21. TRI-



21. TRIANGULUM, the *Triangle*, called also *Deltoion*, because it is like the fourth Letter of the Greek Alphabet  $\Delta$ , which they call *Delta*; it consisteth of four *Stars*. They say it was placed in *Heaven* by *Mercury*, that thereby the head of the *Ram* might be the better known. Others say, that it was placed there in Honour of the *Geometricians*, among whom, the *Triangle* is of no small importance. Others affirm, that *Ceres* in Times past requested *Jupiter* that there might be placed in *Heaven* some Figure representing the form of *Sicily*, an *Island* greatly beloved of *Ceres*, for the Fruitfulness thereof: now this *Island* being *Triangular* (at her request) was represented in the *Heaven* under that Form.

Thus much concerning the Constellations of the Northern Hemisphere. Now follow the Poetical Stories of the Constellations of the Southern Hemisphere.

Secondly,

### Of the Southern Constellations.

1 CETUS, the *Whale*, It is also called the *Lyon*, or *Bear* of the *Sea*. This is that monstrous Fish that should have devoured *Andromeda*, but being overcome by *Perseus*, was afterwards translated into *Heaven* by *Jupiter*, as well for a Token of *Perseus* his Manhood, as for the hugeness of the Fish it self. This *Constellation* consisteth of two and twenty *Stars*.

2. ORION, this hath eight and thirty *Stars*. The Poetical reason of his Translation into the *Heavens*, shall be shewn in the *Scorpion*, amongst the *Zodietical Constellations*. The Ancient *Romans* called this *Constellation* *Jugala*; because it is most plentiful unto Cattel, and as it were the very Cut-throat of them. There are bright *Stars* in his Girdle, which we commonly call our *Ladies yard*, or *Wand*. *Novidius*, applying this *Sword* of *Orion* unto Scripture, will have it to be the sword of *Saul*, afterwards called *Paul*, wherewith he persecuted the Members of *Christ*: which after his Conversion was placed in *Heaven*. In his *Left Shoulder* there is a very Bright *Star*, which in *Latine* is called *Bellatrix* the *Warriour*, in the *Fœminine* gender. I cannot find the reason except it be this; that *Women* born under this

this *Constellation* shall have mighty Tongues: the reason of the *Ox-hide* which he hath in his Hand may be gathered out of the next Story.

3. FLUVIUS, the *River*; it comprehendeth thirty four *Stars*. It is called by some *Eridanus*, or *Padus*; and they say that it was placed in *Heaven* in remembrance of *Phaeton*, who having set the whole World on Fire, by reason of misguiding of his Father *Phœbus* his Chariot, was slain by *Jupiter* with a Thunder-bolt, and tumbling down from *Heaven*, fell into the *River Eridanus*, or *Padus* which the *Italians* call *Po*. Others say it that is *Nylus*, and that that Figure was placed in *Heaven* because of the excellency of that *River*, which by the *Divines* is called *Gibon*; and is one of the *Rivers* of *Paradise*. Others call it *Flumen Orionis* the Flood of *Orion*; and say that it was placed there, to betoken the Off-spring from whence *Orion* came: for the Tale is thus reported of him.

*Jupiter*, *Neptune*, and *Mercury*, travelling upon the *Earth* in the likeness of Men, were requested by *Hyreus* to take a poor Lodging at his House for a Night: they being overtaken with the Evening, yielded unto his request; *Hyreus* made them good Cheer, killing an *Ox* for their better entertainment: The Gods seeing the good heart of the Old Man, willed him to demand what he would in recompence of his so friendly cheer. *Hyreus* and his Wife being old, requested the Gods to gratifie them with a Son. They to fulfil his desire, called for the Hide of the *Ox* that was slain, and having received it, they put it into the *Earth*, and made water into it all three together, and covering it, willed *Hyreus* within ten months after to dig it out of the *Earth* again; which he did, and found therein a Man-child, whom he called *Ourion*, ab *Urina*, of *Piss*; although afterwards by leaving out the second Letter, he was named *Orion*. At such Time therefore as he was placed in *Heaven*, this Flood was joyned hard to his heels, and the *Ox-hide* wherein the Gods did *Piss*, was set in his left Hand, in memorial of his Off-spring.

4. LEPUS, the *Hare*, which consisteth of twelve *Stars*. This *Constellation* was placed in *Heaven* between the legs of *Orion*, to signifie the great delight in Hunting which he had in his Life time: but others think it was a frivolous thing, to say that so notable a Fellow as *Orion* would trouble himself with so small and timorous a Beast as the *Hare*: and therefore they tell the Tale thus.



In Times past there was not a *Hare* left in the Isle *Leros*: a certain Youth therefore of that Island, being very desirous of that kind of Beast, brought with him from another Country thereabout, an *Hare* great with Young; which when she had brought forth, they in Time became so acceptable unto the other Country-men, that every one almost desired to have and keep a *Hare*. By reason whereof, the number of them grew to be so great, whithin a short space after, that the whole Island became full of *Hares*, so that their Masters were not able to find them meat: whereupon the *Hares* breaking forth into the fields, devoured their Corn. Wherefore the Inhabitants being bitten with hunger, joyned together with one consent, and (though with much ado) destroyed the *Hares*. *Jupiter* therefore placed this *Constellation* in the *Heavens*; as well to express the exceeding fearfulness of the beast, as also to teach men this lesson; that there is nothing so much to be desired in this life, but that at one time or another it bringeth with it more grief than pleasure. Some say, that it was placed in *Heaven* at the request of *Ganimedes*, who was greatly delighted with hunting the *Hare*.

5. CANIS MAJOR, the *Great Dog*, it consisteth of eighteen *Stars*. It is called *Sirius Canis*, because he causeth a mighty Drought by reason of his Heat. This is the *Constellation* that giveth the name unto the *Canicular* or *Dog Days*; whose beginning and end is not alike in all Places, but hath a difference according to the Country and Time: as in the time of *Hippocrates* the Physician, who lived before the Time of Christ 400 Years, the *Canicular Days* began the 13, or 14 of *July*. In the Time of *Avicenna*, the *Spaniard*, who lived in the Year of our Lord 1100, the *Canicular Days* began the 15, 16, or 17 of *July*. In our Country, they being about *St. James-tide*, but we use to account them from the 6 of *July*, to the 17 of *August*; which is the Time when the *Sun* beginneth to come near unto, and to depart from this *Constellation*.

*Novidius* will have it to be referred to *Tobias Dog*; which may very well be, because he hath a Tail, *Tobias Dog* had one, as a certain fellow once concluded: because it is written that *Tobias* his Dog fawned upon his Master, therefore it is to be noted (said he) that he had a Tail. The Poets say, that this is the Dog whom *Jupiter* set to keep *Europa*, after that he had stolen her away, and conveyed her into *Greet*, and for his good service

was

was placed in *Heaven*. Others say, that it was one of *Orion* his Dogs. There belong unto this *Constellation* 11 *Stars* unformed.

6. CANIS MINOR, the *Lesser Dog*; this of the *Greeks* is called *Procyon*, of the *Latins* *Ante Canis*; it containeth but two *Stars*. Some say, that this was also one of *Orion* his Dogs. Others rather affirm it to be *Mera* the Dog of *Origone*, or rather of *Icarus* her father, of whom mention is made in the *Constellation* of *Bootes*, and *Virgo*. This Dog of meer love to his Master, being slain, as afore said, threw himself into the River *Anygrus*, but was afterward translated into *Heaven*, with *Origone*. Among the Poets there is great dissention which of the two should be the Dog of *Origone*; some saying one, and some the other, and therefore they do many times take the one for the other.

7. ARGO NAVIS, the *Ship Argo*, which comprehendeth one and forty *Stars*; this is the *Ship* wherein *Jason* did fetch the Golden Fleece from *Colchis*, which was afterward placed in *Heaven* as a Memorial, not only because of the great Voyage, but also, because (as some will have it) it was the first *Ship* wherein any man failed. Their reason why this *Ship* is not made whole is, that thereby men might be put in mind not to despair, albeit that their *Ship* miscarry in some part now and then. Some avouch it to be the *Ark* of *Noe*. *Novidius* saith it is the *Ship* wherein the *Apostles* were, when Christ appeared unto them walking on the *Sea*. In one of the *Oars* of this *Ship*, there is a great *Star*, called *Canopus*, or *Canobus*, which the *Arabians* called *Shuel*, as it were a Bon-fire, because of the greatness thereof. It is not seen in *Italy*, nor in any Country on this side of *Italy*: Some say that *Canobus* the Master of *Mere-lus* his *Ship*, was transformed into this *Star*.

8. HYDRA, the *Hydre*; that hath five and twenty *Stars*, and two unformed.

9. CRATER, the *Cup* or *Standing piece*; that hath seven *Stars*, some say that this was the *Cup* wherein *Tagathon*, that is the chief God, mingled the stuff whereof he made the Souls of Men.

10. CORVUS, the *Crow*; this hath seven *Stars*. These three *Constellations* are to be joyned together, because they depend upon one History, which is this. Upon a time *Apol.* made a solemn feast to *Jupiter*, and wanting water to serve his turn, he delivered a *Cup* to the *Crow* (the Bird wherein he chiefly delighted) and sent

sent him to fetch Water therein. The *Crow* flying towards the *River*, espied a *Fig-tree*, fell in hand with the *Figs*, and abode there till they were Ripe: In the end, when he had fed his fill of them, and had satisfied his Longing, he bethought himself of his Errand, and by reason of his long delay, fearing a check, he caught up a *Snake* in his Bill, brought it to *Apollo*, and told him that the *Snake* would not let him fill the *Cup* with water. *Apol.* seeing the impudency of the Bird, gave him this gift, that as long as the *Figs* were not ripe upon the Tree, so long he should never Drink: and for a memorial of the silly excuse that he made, he placed both the *Crow*, *Cup*, and *Snake* in *Heaven*.

11. **CENTAURUS**, the *Centaure*, which comprehendeth seven and thirty *Stars*. Some say that this is *Typhon*, others call him *Chiron*, the Schoolmaster of those three excellent men, *Hercules*, *Achilles*, and *Æsculapius*; unto *Hercules* he read *Astronomy*, he trained up *Achilles* in *Musick*, and *Æsculapius* in *Physick*: and for his upright Life he was turned into this *Constellation*. Yet *Virgil* calleth *Sagittarius* by the name of *Chiron*. In the *Hinder* feet of this *Constellation*, those *Stars* are set which are called the *Crossiers*, appearing to the *Mariners* as they sail towards the *South Sea*, in the form of a *Cross*, whereupon they have their name. The four *Stars* which are in the *Garnish* of the *Centaurs* *Spear*, are accounted by *Proclus* as a peculiar *Constellation*, and are called by him *Thyriflocbus*, which was a *Spear* compassed about with *Vine Leaves*: but they are called by *Copernicus* and *Clavius*, and other *Astronomers*, the *Stars* of his *Target*. It should seem that they were deceived by the old Translation of *Ptolomy*, wherein *Scutum* is put for *Hasta* (i.e.) the *Target*, for the *Spear*, as it is well noted by our Country-man *M.R. Record*, in his Book intituled *The Castle of Knowledge*.

12. **LUPUS**, the *Wolf*, or the *Beast* which the *Centaur* holdeth in his *Hand*, containeth nineteen *Stars*; the Poetical reason is this; *Chiron* the *Centaur* being a just Man, was greatly given to the Worship of the Gods: for which thing, that it might be notified to all Posterity, they placed him by this *Beast*, which he seemeth to stick and thrust through with his *Spear* (as it were) ready to kill for Sacrifice.

13. **ARA**, the *Altar*, it is also called *Lar*, or *Thuribulum*, (i.e.) a *Chilmeny* with the *Fire*, or a *Cenfor*. It consisteth of seven *Stars*, and is affirmed of some Poets, to be the *Altar* whereon

on the *Centaur* was wont to offer up his Sacrifice. But others tell the Tale thus. When as the great *Gyants*, called the *Tytans*, laboured as much as might be to pull *Jupiter* out of *Heaven*, the Gods thought it good to lay their heads together, to advise what was best to be done: Their conclusion was, that they should all with one consent joyn hands together to keep out such fellows; and that this their league might be confirmed, and thoroughly ratified; they caused the *Cyclops* (which were workmen of *Vulcan*) to make them an *Altar*: about this *Altar* all the Gods assembled, and there swore, that with one consent they would withstand their Enemies; afterwards, having gotten the Victory, it pleased them to place this *Altar* in *Heaven*, as a Memorial of their League, and a token of that good which unity doth breed.

14. **CORONA AUSTRINA**, the *South Garland*, it hath 13 *Stars*. Some say that it is some trifling *Garland* which *Sagittarius* was wont to wear, but he cast it away from him in jest, and therefore it was placed between his Legs: others call it the *Wheel of Ixion*, whereupon he was tormented for that great discourtesie he would have offered unto *Juno*, thinking indeed to have gotten up her belly: but *Jupiter* seeing the impudency of the Man, tumbled him out of *Heaven* (where by the Licence of the Gods he was sometime admitted as a guest) into *Hell*, there to be continually tormented upon a *Wheel*. The Figure of which *Wheel* was afterwards placed in *Heaven*, to teach men to take heed how they be too saucie to make such courteous proffers unto other Mens Wives. The *Greeks* call this *Constellation* by the name of *Uraniscus*, because of the Figure thereof: For it representeth the *Palate* or *Roof* of the mouth, which they call *Uraniscus*.

15. The last is **PISCIS AUSTRINUS**, or *Notius*, the *South Fish*, which comprehendeth eleven *Stars*, besides that which is in the Mouth thereof, belonging to the *Water*, which runeth from *Aquarius*, and is called by the *Arabians* *Fomabant*. The reason why this *Fish* was placed in the *Heaven*, is uncertain: yet some affirm, that the Daughter of *Venus* going into a *Water* to Wash her self, was suddenly transformed into a *Fish*, the which *Fish* was afterwards translated into *Heaven*; The unformed *Stars* belonging unto this *Constellation* are six.

Thus much concerning the *Constellation* of the *Northern* and *Southern* Hemispheres; now follow the Poetical Stories of the *Zodiacal Constellations*.  
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### Of the Zodical Constellations.

1. **ARIES**, the *Ram*, is called by the *Greeks* *Crios*; it containeth in it thirteen *Stars*, which were brought unto this *Constellation* by *Thyestes*, the son of *Pelops*, and Brother of *Acreus*. This is the *Ram* upon which *Prinxus*, and *Helle* his sister, the Children of *Atbamas* did sit, when they fled from their Step-mother *Ino*, over the *Sea* of *Hellepont*: which *Ram* was afterwards for his good service, translated into *Heaven* by *Jupiter*. Others say, that it was that *Ram* which brought *Bacchus* unto the spring of *Water*, when through Drought he was likely to have perished in the Desert of *Lybia*. *Novidius* will have this to be the *Ram* which *Abraham* offered up instead of his son *Isaac*. The *Star* that is First in the Head of the *Ram*, is that from whence our later *Astronomers* do account the *Longitude* of all the Rest, and it is distant from the Head of *Aries*, in the tenth *Sphere*, 27 Degrees 53 Minutes. The unformed *Stars* belonging unto this *Constellation*, are five.

2. **TAURUS**, the *Bull*, which consisteth of twenty three *Stars*. This was translated into *Heaven* in Memorial of the Rape committed by *Jupiter* on *Europa* the Daughter of *Agenor*, King of *Sidon*; whom *Jupiter* in the likeness of a White *Bull* stole away, and transported into *Candia*. Others say, That it was *Io* the Daughter of *Inacus*: whom *Jupiter* loved, and turned into the form of a Cow, to the intent that *Juno* coming at unawares, should not perceive what part he had played: *Jupiter* afterward in memorial of that crafty conveyance, placed that Figure in *Heaven*; The reason why the Poets name not certainly whether it be a Cow or a Bull, is because it wanteth the hinder Parts; yet of the most of them it is called a *Bull*. In the Neck of the *Bull* there are certain *Stars*, standing together in a cluster, which are commonly called the *Seven Stars*: although there can hardly be discerned any more than six. These are reported to be the seven Daughters of *Atlas*, called *Atlantiades*, whereof six had company with the Immortal Gods, but the seventh (whose name was *Alcerope*) being married unto *Sysiphus* a mortal Man, did there-

therefore withdraw and hide her Self, as being ashamed that she was not so fortunate in matching herself as her Sisters were. Some say, that that *Star* which is wanting is *Electra*, the eldest Daughter of *Atlas*, and that therefore it is so dim, because she could not abide to behold the destruction of *Troy*; but at that time and ever since, she hid her face. The reason why they were taken up into *Heaven*, was, their great pity towards their Father, whose mishap they bewailed with continual Tears. Others say, that whereas they had vowed perpetual virginity, and were in danger to lose it, by reason of *Orion*, who greatly assailed them, being overtaken with their Love; they requested *Jupiter* to stand their Friend, who translated them into *Stars*, and placed them in that part of *Heaven*. The Poets call them *Pleiades*, because when they rise with the *Sun*, the Mariners may commit themselves to the *Sea*. Others will have them to be so termed a *pluendo*; because they procure rain. Others give them this name, of the Greek word *Cleignes*, because they be many in number. They be also called *Vigilia*, because they rise with the *Sun* in the Spring time: likewise *Athorais*, because they stand so thick together. Our men call them by the name of the *Seven Stars*, or *Brood Hen*. The *Astronomers* note this as a special thing concerning these *Stars*, that when the *Moon* and these *Stars* do meet together, the eyes are not to be meddled withal, or cured if they be sore: their reason is, because they be of the Nature of *Mars* and the *Moon*.

Moreover, there be five *Stars* in the Face of the *Bull*, representing the form of the *Roman* letter V, whereof one (which is the greatest) is called the *Bull's Eye*. They be called *Hyades*, and were also the Daughters of *Atlas*, who so long bewailed the death of *Hyas* their Brother, slain by a *Lyon*, that they died for sorrow, and were afterwards placed in *Heaven*, for a Memorial of that great Love they bore to their Brother. The Ancient *Romans* call the *Bull's Eye* *Parilicium*, or *Palelicium*, of *Pales* their Goddess; whose Feast they celebrated after the conjunction of this *Star* and the *Sun*. The unformed *Stars* belonging unto this *Constellation*, are eleven.

3. **GEMINI**, the *Twins*; it consisteth of eighteen stars. The Poets say, they are *Castor* and *Pollux*, the Sons of *Leda*, brethren most loving, whom therefore *Jupiter* translated into *Heaven*. Some say that the one of them is *Apollo*, and the other *Hercules*;

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les: but the most affirm the former. The unformed Stars of this *Constellation* are seven, whereof one is called *Tropus*, because it is placed next before the *Foot of Castor*.

4. **CANCER**, the *Crab*, it hath nine Stars. This is that *Crab* which bit *Hercules* by the Heel as he fought with the Serpent *Hydra* in the Fen *Lerna*, and for his forward service, was placed in *Heaven* by *Juno*, the utter Enemy of *Hercules*. In this *Constellation* there are Stars much spoken of by the Poets, although they be but small; whereof one is called the *Crib*, other two are the two *Asses*, whereof one was the *Ass* of *Bacchus*, the other of *Vulcan*, whereon they rode to battel, when as the Gyants made War with the Gods; with whose Braying and strange Noise, the Gyants were so scared upon the sudden, that they forsook the Field, and Fled. The Gods getting the Victory, in triumphing manner translated both the *Asses*, and their Manger into *Heaven*. The unformed Stars of this *Constellation* are four. It is called *Animal Retrogradum*, for when the *Sun* cometh into this *Sign*, he maketh *Retrogradation*.

5. **LEO**, the *Lion*, it hath 27 Stars, this is that *Lion* which *Hercules* overcame in the Wood of *Nemaa*, and was placed in *Heaven* in remembrance of so notable a Deed. *Novidius* saith, this was one of the *Lions* which were in the Den into which *Daniel* was cast, and was therefore placed in *Heaven*, because of all other he was most friendly unto *Daniel*. In the *Brest* of this *Constellation* is that notable great Star, the light whereof is such, as that therefore it is called by *Astronomers* *Bazileus* or *Regulus* (i.e.) the *Viceroy*, or little King among the rest. The unformed Stars belonging to the *Lion* are eight; whereof three make the *Constellation* which is now called *Coma Berenices*, that is, the hair of *Berenice*. This *Constellation* was first found out and invented by *Canon* the *Mathematician*, but described by *Calimachus* the Poet. The occasion of the Story was this. *Ptolomeus Euergetes* having married his sister *Berenice*, was shortly after enforced to depart from her, by reason of the Wars he had begun in *Asia*: whereupon *Berenice* made this vow, that if he returned home again in safety, she would offer up her hair in *Venus* Temple. *Ptolomey* returned safe; and *Berenice*, according to her vow, cut off her hair and hung it up. After certain Days, the hair was not to be found; whereupon *Ptolomey* the King was greatly displeased: but *Canon*, to please the humor of the King, and to

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carry favour with him, perswaded him that *Venus* had conveyed the Hair into *Heaven*. *Canon* attributeth seven Stars unto it, but *Ptolomey* alloteth it but three, because the other be insensible.

6. **VIRGO**, the *Virgin*, it hath twenty six Stars. This is affirmed to be Justice, which among all the Gods sometime living upon the *Earth*, did last of all forsake the same, because of the Wickedness that began to multiply therein, and chose this Place for her Seat in *Heaven*.

Others say, that it was *Astraea*, the Daughter of *Astræus*, one of the Gyants that were called *Titans*, who fighting against the Gods, *Astræa* took their parts against her own Father, and was therefore after her death commended unto the *Heavens*, and made one of the Twelve *Signs*.

Others say, that it was *Erigone*, the Daughter of *Icarius*, who for that her Father was slain by certain Drunken men, for very Grief thereof hanged her self: but *Jupiter* taking pity of the *Virgin* for her Natural affection, translated her into *Heaven*.

In her right wing there is one Star of special note, which by the *Astronomers* is called *Vindemiator* (i.e.) the gatherer of Grapes. This was *Ampelos* the Son of a Satyr and a Nymph, and greatly beloved of *Bacchus*, unto whom in token of his love, *Bacchus* gave a singular fair Vine, planted at the foot of an Elm (as the manner was in old time.) But *Ampelos* in Harvest gathering Grapes, and taking little heed to his footing, fell down out of the Vine, and brake his neck. *Bacchus*, in Memorial of his former affection, translated him into *Heaven*, and made him one of the principal Stars in this *Constellation*. There is another great Star in the hand of the *Virgin*, called of the *Latins* *Spica*, of the *Greeks* *Stachus*, of the *Arabians* *Azimach* (i.e.) the Ear of Corn: whereby they signify, that when the *Sun* cometh to this *Sign*, the Corn waxeth Ripe. *Albumazer* the *Arabian*, and *Novidius*, take this *Constellation* for the *Virgin Mary*. The unformed Stars in this *Constellation* are six.

7. **LIBRA**, the *Ballance*, it containeth 8 Stars; *Cicero* calleth it *Jugum* the *Yok*, and here it is to be noted, that the ancient *Astronomers* that first set down the number of the *Constellations* contained in the *Zodiack*, did account but eleven therein, so that the *Sign* which now is called *Libra*, was heretofore called *Chelai*, that is to say, the Claws of the *Scorpion*, which possesseth the space of two whole *Signs*. But the later *Astronomers*, being de-

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sirous to have Twelve Signs in the Zodiack, called those eight whereof the *Claws of the Scorpion* do consist, by the name of *Libra*, not that there was any Poetical Fiction to induce them thereto, but only moved by this reason, because the *Sun* joyn- ing with this *Constellation*, the Day and the Night are of an equal Length, and are (as it were) equally poyzed in a pair of *Ballance*. Yet (as I remember) some will have this to be the *Ballance* wherein Justice, called also *Astraea*, weighed the deeds of mortal men, and therein presented them unto *Jupiter*. It hath nine unformed Stars appertaining unto it.

8. SCORPIO, the *Scorpion*; called of the *Arabians*, *Alatrab*; of *Cicero*, *Nepa*. It consisteth of twenty one Stars. The Fiction is thus; *Orion* the Son of *Hyreus* greatly beloved of *Diana*, was wont to make his boast, that he was able to overcome what beast soever was bred upon the *Earth*: The *Earth* being moved with this speech brought forth the *Scorpion*, whereby *Orion* was stung to death. *Jupiter* thereupon (at the request of the *Earth*) translated both the *Scorpion* and *Orion* into *Heaven*; to make it a Lesson for ever, for mortal men, not to trust too much unto their own Strength: and to the end he might signify the great enmity between them, he placed them so in the *Heaven*, that whensoever the one riseth, the other setteth; and they are never both of them seen together above the *Horizon* at once: *Gulielmus Postellus* will have it to be the *Serpent* which beguiled *Eve* in *Paradise*. The unformed Stars about this *Scorpion* are three.

9. SAGITTARIUS, the *Archer*. It hath 31 Stars. Touching this Sign, there are among the Poets many and sundry Opinions. Some say that it is *Crocus*, the Son of *Pupbene*, that was nurse unto the *Muses*. This *Crocus* was so forward in learning of the Liberal Sciences, and in the practice of Feats of Activity, that the *Muses* entreated *Jupiter* that he might have a place in *Heaven*. To whose request *Jupiter* inclining, made him one of the 12 Signs: And to the end that he might express the excellent qualities of the Man, he made his hinder parts like unto a *Horse*, thereby to signify his singular knowledge in Horse-manship; and by his *Bow* and *Arrow*, he declared the sharpness of his Wit. Whereupon the *Astrologers* have this conceit, that he that is born under *Sagittarius*, shall attain to the knowledge of many Arts, and be of prompt Wit, and great courage. *Virgil* affirmeth this to be *Chiron* the *Centaur*, who for his singular Learning and Justice

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was made the Master of *Achilles*. At which time *Hercules* coming to visit him (for he had heard both of the Worthiness of the School-master, and of the great hopes of the Scholar) brought with him his Quiver of Arrows dipped in the Blood of the Serpent *Hydra*, but *Chiron* being desirous to see his shafts, and not taking heed of them being in his hand, let one of them fall upon his foot, and being greatly tormented, not only by the anguish of the poyson working in the wound, but much more because he knew himself to be Immortal, and his wound not to be recovered by medicine, he was enforced to make request unto the Gods, that he might be taken out of the *World*, who pitying his case, took him up into *Heaven* and made him one of the Twelve Signs.

10. CAPRICORNUS, the *Goat*, it consisteth of 28 Stars. The Poets say, that this was *Pan*, the God of the shepherds, of whom they feign in this manner: The Gods having war with the Gyants, gathered themselves together into *Egypt*, *Typhon* the Gyant pursued them thither, whereby the Gods were brought into a quandary, that well was he that by changing his shape might shift for himself. *Jupiter* turned himself into a *Ram*: *Apollo* became a *Crow*: *Bacchus* a *Goat*: *Diana* lurked under the form of a *Cat*: *Juno* transformed her self into a *Cow*: *Venus* into a *Fish*: *Pan* leaping into the River *Nilus*, turneth the upper part of his body into a *Goat*, and the lower part into a *Fish*. *Jupiter* wondring at his strange device, would needs have that Image and Picture translated into *Heaven*, and made one of the Twelve Signs. In that the hinder part of this Sign is like a *Fish*, it betokeneth that the latter part of the Month wherein the *Sun* possesseth this Sign, enclineth unto Rain.

11. AQUARIUS, the *Waterman*: It hath 42 Stars, whereof some make the Figure of the *Man*; other some the *Water-pot*; and some, the *Stream of Water* that runneth out of the *pot*. This is feigned to be *Ganymedes* the *Trojan*, the son of *Oros* and *Callirhoe*, whom *Jupiter* did greatly love for his excellent favour and beauty, and by the service of his Eagle carried him up into *Heaven*, where he made him his Cup-bearer, and called him *Aquarius*. Others notwithstanding think it to be *Deucalion* the son of *Prometheus* whom the Gods translated into *Heaven*, in remembrance of that mighty deluge which hapned in his time, whereby mankind was almost utterly taken away from the face of the *Earth*. The unformed Stars belonging unto this Sign are three.

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12. PISCES, the *Fishes*: these together with the *Line* that knitteth them together, contain twenty four *Stars*. The Poets say, that *Venus* and *Cupid* her Son coming upon a certain time unto the River *Euphrates*, and sitting upon the Bank thereof, upon a sudden espied *Typhon* the *Giant*, that mighty and fearful Enemy of the Gods coming towards them; Upon whose Sight, they being stricken with exceeding Fear, leapt into the River, where they were received by two *Fishes*, and by them saved from drowning. *Venus* for this good turn, translated them into *Heaven*. *Gulielmus Postellus* would have them to be the *Two Fishes* wherewith Christ fed the 5000 Men. The unformed *Stars* of this *Constellation* are four.

Thus have I briefly run over the Poetical reasons of the *Constellations*: It remains now that I speak of the *Milky way*.

VIA LACTEA, or *Circulus Lacteus*, by the *Latins* so called; and by the *Greeks* *Galaxia*; and by the *English*, the *Milky way*. It is a broad White Circle that is seen in the *Heaven*: in the *North Hemisphere*, it beginneth at *Cancer*, on each side the Head thereof, and passeth by *Auriga*, by *Perseus*, and *Cassiopeia*, the *Swan*, and the Head of *Capricorn*, the Tail of *Scorpio*, and the Feet of *Centaur*, *Argo* the *Ship*, and so unto the Head of *Cancer*. Some in a sporting manner do call it *Watling-street*, but why they call it so, I cannot tell; except it be in regard of the narrowness that it seemeth to have; or else in respect of that great High Way that lyeth between *Dover* and *S. Albans*, which is called by our men, *Watling-street*.

*Ovid* saith, that it is the great Causey, and the High-way that leadeth unto the Palace of *Jupiter*; but he alledgeth not the cause of the Whiteness: belike he would have us imagine that it is made of White Marble.

Others therefore alledge these causes: *Jupiter* having begotten *Mercury* of *Maia* the Daughter of *Atlas*, brought the Child when he was born, to the Breast of *Juno* lying asleep: But *Juno* awaking threw the child out of her Lap, and let the milk run out of her breast in such abundance that (spreading it self about the *Heaven*) it made that Circle which we see. Others say, that it was not *Mercury*, but *Hercules*; and that *Juno* did not let the milk run out of her breast, but that *Hercules* sucked them so earnestly, that his Mouth run over, and so this Circle was made.

Others say, that *Saturn* being desirous to devour his children,

his

his wife *Ops* presented him with a Stone wrapped in a Clout, instead of his Child: This Stone stuck so fast in *Saturn* his Throat as he would have swallowed it; that without doubt he had therewithall been choaked, had he not been relieved by his Wife, who by pressing the Milk out of her Breasts saved his Life: the Milk that missed his Mouth (whereof you must suppose some sufficient quantity) fell on the *Heavens*, and running along made this Circle.

*Dr. Hood* commenting upon *Constellations*, saith; The *Stars* are brought into *Constellations*, for Instruction sake, Things cannot be taught without Names: to give a Name to every *Star* had been troublesome to the Master, and for the Scholar; for the Master to Devise, and for the Scholar to remember: and therefore the *Astronomers* have reduced many *Stars* into one *Constellation*; that thereby they may tell the better where to seek them; and being sought, how to express them. Now the *Astronomers* did bring them into these Figures, and not into other, being moved thereto by these three Reasons.

First, these Figures express some properties of the *Stars* that are in them; as those of the *Ram* to be hot and Dry; *Andromeda* Chained betokeneth Imprisonment, the Head of *Mедуsa* Cut off, signifieth the loss of that part: *Orion* with his terrible and threatening gesture, importeth Tempest and terrible Effects. The *Serpent*, the *Scorpion* and the *Dragon*, signify Poyson: The *Bull* insinuateth a Melancholy Passion: The *Bear* inferreth Cruelty, &c.

Secondly, the *Stars* (if not precisely, yet after a sort) do represent such a Figure, and therefore that Figure was assigned them: as for Example, the *Crown*, both *North* and *South*, the *Scorpion*, and the *Triangle*, represent the Figures which they have.

The third cause was, the continuance of the Memory of some notable Men, who either in regard of their singular Pains taken in *Astronomy*, or in regard of some other notable Deed, had well deserved of Man-kind.

The first Author of every particular *Constellation* is uncertain; yet are they of great Antiquity; we receive them from *Ptolemy*, and he followed the *Platonicks*; so that their Antiquity is great. Moreover, we may perceive them to be Ancient by the Scriptures, and by the Poets. In the 38 Chapter of *Job* there

is



is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which some interpret the Twelve Signs: *Job* lived in the Time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commensurandis Locorum Distantiis*.

Now besides all this, Touching the reason of the Invention of these *Constellations*, the Poets in setting forth those *Stories*, had this purpose, to make them fall in Love with *Astronomy*: When *Demosthenes* could not get the people of *Athens* to hear him in a matter of great Moment, and profitable for the Commonwealth, He began to tell them a Tale of a Fellow that sold an *Ass*; by the which Tale he so brought on the *Athenians*, that they were both willing to Hear his whole Oration, and to put in Practice that whereunto he exhorted them. The like intent had the Poets in these *Stories*: They saw that *Astronomy* being for Commodity singular in the Life of Man, was almost of all men utterly neglected: Hereupon they began to set forth that Art under these Fictions; that thereby such as could not be perswaded by commodity, might by the Pleasure be induced to take a View of these Matters, and thereby at length fall in Love with them. For commonly note this, that he that is ready to Read the *Stories*, cannot content himself therewith, but desireth also to know the *Constellations*, or at leastwise some Principal *Star* therein.

FINIS.

A  
DISCOURSE  
Of the  
*Antiquity, Progress and Augmentation*  
Of  
ASTRONOMY.

FIRST it seems not to be doubted, but that there was some kind of Observation of Bodies *Cælestial*, as soon as there were Men: considering that the Spectacle which the *Heavens* constantly present, is both so Glorious, and so Useful, that Men could not have Eyes to see, and not fix them Attentively and Considerately thereupon. For, among other Apparences, when they saw the *Sun* daily to change the Places of its Rising and Setting, at certain Times of the Year: to approach nearer to the *Earth* in its Diurnal Arch, and at others again to mount up to a Height much more sublime and remote from it: and that his coming nearer to the *Earth* made *Winter*, and his remove Higher made *Summer*: we say, when they Beheld these things, doubtless they could not but seriously remark and consider this vicissitude, according to which they might expect the Season would be more Hard, or Mild, to them in this lower Region of the World. Again, so admirably Various did the Moon appear, in her several Shapes and Dresses of Light, that she could not but invite Mens Eyes, and engage them to frequent Speculations: especially when She assumed those various Faces or appearances, at set and certain Times; in respect whereof it came to pass, that every Nation Measured their Times & Seasons, by those her constant and Periodical Circuits; & this, because those Periods succeeded much more frequently than the Erections and Depressions of the

H h

Sun.

Articl. 1.  
Observations  
Cælestial, from  
the beginning  
of the World;  
though rude  
and in artificial.



*Sun.* To these, we may add that beautiful shew of the Nightly Stars, undergoing likewise their Variations, according to the variety of Seasons; & more particularly that bright Star of Lucifer, Rising sometimes Later sometimes Earlier, and sometimes not at all before the Sun, and the like. But, what we shall principally note, is only this; that though Mankind was Long, before they came to make enquiries into the causes of these *Celestial* Changes and variations, restrained to set Periods: yet they Observed them from the very First Age, and not only Admired, but also accommodated what they Observed, to the Uses of their Lives and their Successors. Here it might not be fruitless, to remember that *Prometheus*, who was imagined to have framed the First Man, was also imagined to have given him an erected Figure, and sublime Countenance; to the end he might the more advantageously advance his Eyes to the Heavens, and contemplate the Glory and Motions of the *Celestial* Lights. But because this is too General, and rude a way of Observation; and it is our business to look back into those Times wherein Men first made such Observations of Syderal Bodies, as gave them the hint and occasion of reducing them to Method, and founding the Principles of the Art, or Science of *Astronomy*, thereupon: we must have recourse to the monuments in Sacred Writ, for the understanding of that obscure matter.

Articl. II.  
Sacred records  
examined, and  
Moses found to  
be the First A-  
tronomer there  
spoken of. lib. 1.  
Int. c. 3.

And indeed, the Light we expect from Sacred Leaves, would soon be clear enough to discuss all the Darknes, wherein the Original of *Astronomy* seems involved; could we but from them deduce the least evidence for that which the learned Antiquary among the Jews, *Josephus* affirms of the Sons of *Seth*; viz. that they invented the Science of the Heavens, before the Flood, and engraved the same on two Pillars, the one of Brick, the other of Stone, that so it might be preserved in the one, in case the Fury of the Deluge to come, should demolish and deface the other: or if there remained to us any the most slender Testimony of the Reason he there gives, of the so great Longevity of Men in those Days; namely, that the duration of their Lives was sufficiently long, to perfect the knowledg of *Astronomy*, which requires full 600 Years, at the least, to the Observation of all the Varieties of *Celestial* Motions: Whereupon he notes, that the Great Year (as they call it) doth consist of six hundred Common Years; the vulgar opinion being, that the *Celestial* Motions do continually vary.

Donec.

Donec consumpto, Magnus qui dicitur, Anno,  
Rursus in antiquum redeant vaga sidera cursum,  
Qualia præteriti steterant ab origine mundi.

Epigram. de  
stat. Anim.

Again, the business might be deduced from not long after the Flood, if in Scripture we could find but the least word from whence might be argued the truth of what the same Author writes; namely, that the *Egyptians* were taught *Astronomy*, by *Abraham*. Probable enough it is, we confess, that *Berosus*, and others, quoted as well by *Josephus*, as *Eusebius*, had read some such thing in some Book of the old Rabbins: but that the same should be fetched from Holy Writ, is most improbable; therein being no mention at all of any such thing. Besides, there are Pious and Learned Doctors, and among them *Salianus*, who will not allow it to be so much as probable, that *Abraham* should instruct the *Egyptians* in *Astronomy*: because of the very small Time of his stay among them in *Egypt*. It is written indeed, that *Abraham* came from *Ur* of the *Chaldeans*: but not that he received *Astro-*

Gen. 11.

Gen. 47.

I. Polit. cap. 1.  
and Metaph.  
cap. 1.

H h 2

Country

cap. 4.

try Employments, and was wholly ignorant of all Arts and Sciences, at his first coming among them; being afterwards advanced to the height of a Courtier, and lustre of a Favorite, had been instructed by them in something more noble and sublime. And truly the Divine *Moses*, not long after admitted into the same Court, is not delivered so much to have erudited any others, as to have been himself learned in all the Wisdom of the *Egyptians*. Nevertheless considering that this Wisdom of the *Egyptians*, doubtless contained the *Mathematicks*; and that *Astronomy* was ever esteemed the best and noblest part of them: this Erudition of *Moses* seems to be the most Ancient Monument of the Science of the *Stars*, that can be found in Holy Writ.

*Astronomy* you see is of great Antiquity, even upon the Records of Divinity; and might be proved of much greater, could we but evince (what some alledge) that the History of *Job* was Pen'd by *Moses*, as living a good while after him. Because *Job* there mentions *Arcturus*, *Orion*, and the *Hyades*, or Watery Constellation: and therefore it must be, that before that Time the *Stars* had been ranged and disposed into certain *Asterisms*, according to some certain method or artificial Theory then in Use. But be the Time of his life never so uncertain, yet we may certainly observe from the History thereof; that it seems *Job*, being an Alien to the *Hebrews*, derived his knowledge of God from that which in Scripture is called *Cælorum Exercitus*, the Host of Heaven. Forasmuch, as the Invisible things of God are not so well learned from any visible things of Nature, or the effects of his Wisdom & Power, as from the *Cælestial* Orders, and therefore *Synesius* justly calling *Astronomy* [*ὑπεράμωρον ἐπιστήμην*] a truly venerable Science; he saith, that it advanceth the Mind to something of greater both Antiquity and Nobility, viz. ineffable Theology. That we may be brief, and only touch upon that sentence in the Book of Wisdom that God gave to *Solomon*, among other of Natural Sciences, to understand the Course of the Year, and the dispositions of the *Stars*: If any thing in Sacred Writ doth expressly prove the Antiquity of Observations *Astronomical*, and the founding or erecting any settled Art thereupon; it must be that, of which the Holy Prophets complain'd in their days; viz. that there were *Chaldeans*, who at *Babylon* did contemplate the *Stars*, and compute the Months, that from them they might foretell things to come. For, from hence we understand, that the Observations of the Motions of *Heavenly* Bodies was a certain profest Art; and of great

Art. 7.

Cap. 9.

De done ad  
Fan.

Cap. 7.

Isa. 47.

great Antiquity among the *Chaldeans*.

In the Second place we are to revolve the Records of *Ethnick Authors*, to see if among them we can find the Time of the Nativity of *Astronomy*.

Look we therefore back First, into the Remains of that part of Time, which is called *Obscure* or *Fabulous*; because possibly enough something of Truth, concerning our enquiry, may be found wrapt up in the darksome shrouds of *Fables*. And begin we at the most Ancient of *Heathen Gods*, *Cælus*, in Greek *Οὐρανός*, who, as *Diodorus Siculus* delivers, was so named, because of his High Devotion to, and delight in the Observation of the *Stars*. This eminent Person being the Father of many Sons, as *Atlas*, *Saturnus*, the *Titanes*, and among those, especially *Hyperion* and *Japetus*; it is lawful for us to conjecture, that led by his Example, his whole family were addicted to the same Study. For seeing, that *Cælus* lived in *Mauritania*, not far from the Ocean; & thence extended his Kingdom, not only over all *Africa*, but also into a considerable part of *Europe*: it is well known that his Son *Atlas* who succeeded him in the same Dominions, is allowed to have given his name to the highest Mountain of that Country; only because he had made his Observations of the Motions of the *Heavens* and *Stars*, from the top thereof. For the Ancients in those Days, as the *Vulgar* now in ours, imagined the Arch of the *Heavens* to be so little distant from the tops of great Mountains, as that by how much the Higher any man ascended on those Hills, by so much the more clearly & distinctly might he behold *Cælestial* Objects. To this, *Diodorus*, *Plinie*, and others add; that *Atlas* was feigned to support *Heaven* on his Shoulders, only because He had Framed a *Sphere*, wherein the whole *Heavenly* machine was strongly represented: and *Clemens Alexandrinus* Observes, that *Hercules*, being both *Vates* & *Physicus*, a Prophet and Philosopher, was reported to come and relieve *Atlas* (his great Uncle) by taking the vast Burden of *Heaven* upon his own Shoulders; because He succeeded him in that difficult Task, the Study, or science of *Cælestial* Bodies. Of *Hesperus*, the Son of *Atlas*, it is recorded, that while he was busie in speculating the *Stars*, on the top of the same Mountain, he was snatched away by the violence of some Disease, & could never be found: & that thereupon, the common People, in respect of his Piety and Justice, gave his name to the most beautiful & resplendent *Star*, which is also called *Vesperugo*, being *Venus*, while the

Articl. 3.  
Ethnick monuments like-  
wise revolved, and first those of Fabulous times: according to which *Cælus* is found the most ancient *Astronomer*.  
lib. 3.

and after him his Sons.

1.  
*Atlas*, who taught *Astronomy* to his Son.

lib. 3.  
lib. 2. cap. 8.

Stron. 1.

*Hesperus*.

And Daugh-  
ters, the Atlan-  
tiades and Plei-  
ades, from one  
of whom came  
Mercury.  
I Astron.

She is in the *West*. As for his Sisters, called both *Atlantiades*, and *Pleiades*: these likewise gave their name to that Glomeration of *Stars*, which are visible in the Back of *Taurus*, and of one of them, named *Alaia*, was born the famous *Mercurius*; said to have brought the Science of the *Stars* first into *Egypt*. Whence *Marcilius*, writing of the *Astronomy* of the *Egyptians*, Says of *Mercury*,

*Tu Princeps, Authorq; sacri, Cyllenie, tanti Sc.*

lib. 3.  
lib. de Astron.  
5. Tifculan.

Though we well know, that the *Aethiopians*, allowing the *Egyptians* to be no other, but one of their *Colonies*, sent abroad to find room to subsist in, contend, That they received *Astronomy* from them: as first *Diodorus*, and after *Lucian* have observed. Here it is well worthy our Commemoration, what *Cicero* saith, as of *Atlas* and *Prometheus*, so also *Cepheus*, a King of the *Ethiopians*: viz. "Neither had *Atlas* been beleived to have sustain'd *Heaven*, nor "*Prometheus* to have been chain'd on *Caucasus*: nor *Cepheus* with "his Wife, Son-in-Law, and Daughter, to have been Stellified: "had not their Divine cognition of *Celestial* Bodies first occasi- "oned the perpetuation of their Names in the disguise of Fables.

2.  
Saturn, who  
delivered the  
same to his Son.

To return to *Saturn* another Son of *Cælus*; He, leaving *Africa*, and Reigning only in *Italy*, *Sicily* and *Crete*; may be thought to have prosecuted his Fathers Studies, no less than the former: and we have this Argument for it, that the slowest of all the *Planets* bears his Name, to this very Day: probably, because he was the first who understood the Motion and course of that *Planet*, which was by the *Greeks* called *Κεβ* from *Χεβ* Time, forasmuch as of all the *Celestial* Circuits, none was found so diuturn. And of his Sons, since *Pluto* addicted himself intirely to *Husbandry*, *Neptune* to *Navigation*; we may conceive, that *Jupiter* applying his mind to nobler cares, succeeded his Father in the Study of the *Heavens*: as also that he chose *Olympus*, accounted the highest Mountain, to make his Observations upon: so that in process of Time he came therefore to be called *Olympus*; and the name of that Mountain to be transferred upon *Heaven* it self, whose orders and laws He well understanding, was thereupon said to have the Dominion of *Heaven*.

Ising. ad  
Phœn.

Certain it is, that the *Grecians* ascribed the Original of this noblest Science, partly to the *Gods* themselves, and partly to ancient *Hero's*; which *Achilles Tatius* seasonably alluding unto, introduceth old *Æschylus* attributing to God, that He shewed the

Risings

Risings and Settings of the *Stars*, and distinguish't Winter, Summer, and the other Seasons; and *Ovid* Fathers the same wholly upon *Jupiter*.

*Perq; Hiemes, Æstusq; & in æquales Autumnos,* <sup>I Metamorph.</sup>  
*Et breve Ver, spatii exegit quatuor Annum.*

Besides, it is in the Fiction that *Jupiter* took his Father, *Saturn*, bound him, and precipitated him into *Hell*. Now this seems to intimate, that *Jupiter* having imposed his own name upon one of the most eminent and illustrious of the *Planets*, gave that of his Father to another of them, that was more remote, situate in the deepest parts of the *Æthereal* spaces, and of the slowest Progress: though all this while we are not ignorant, that those names were fixed upon those *Planets* a long Time after: since more anciently the *Planet Jupiter* was called *Phaeton*, and that of *Saturn*, *Phæon*. For, we may collect very neer as much from *Lucian*, who by *Tartarus* understands the immense Altitude, or Profundity of the *Æthereal* Region: and so denies that *Saturn* was either exil'd by *Jupiter* into *Hell*, or cast into bonds; as common Heads were perswaded to believe.

As for *Hyperion*; *Diodorus* hath a Tradition, that he being of the Progeny of old *Cælus*, demonstrated the courses of the *Sun* and *Moon*: and therefore called the *Sun Helios*, after the name of <sup>3</sup> *Hyperion*. his *Sun*; and the *Moon*, *Selene*, after that of his Daughter.

Last of all comes *Japetus*, who also was the Son of *Cælus*, but performed nothing worthy commendation in the advance of his Fathers Speculations: but *Prometheus*, whom he Begat, was <sup>4.</sup> *Japetus*. therefore imagined to have been chained on the Hill *Caucasus*, and to have his Heart perpetually torn by a hungry *Eagle* or *Vultur*; Because (as *Servius* expounds the Riddle) with restless care, and sollicitude of Mind, he constantly excruciated himself with Observing the *Stars*, and Studying their *Ascensions* and *Declinations*. We shall not insist upon what follows in the same Author, namely that this *Prometheus* was the first, who introduced *Astrology* to the *Assyrians* (not far from *Caucasus*: ) it being more useful for us now to observe, that He was imagined to have stolen *Fire* from *Heaven*, for the in- animation of Man, for no other reason, but because he infused this *Heaven-fetched* Knowledge into the Breasts of Men, and inflamed their Souls with the desire and Love thereof.  
For,

<sup>3</sup> *Hyperion*.  
<sup>4.</sup> *Japetus*.  
From whom  
came Prome-  
theus, who fol-  
lowed the same  
study. in Eccl. 7.

lib. 2.  
lib. 37. c. 10.  
For, as to the remainder; forasmuch as *Belus* was the same with *Jupiter*, among the *Assyrians*, as *Diodorus* testifieth: it is He rather, who was accounted both the most sacred of their Dieties, and the Inventor of this *Sideral Science*; as *Pliny* affirms.

So did Phaeton, It is not needful for us here to examine many other of the ancient Traditions, accounted likewise among the Fabulous; as, in particular, the Fable of *Phaeton*, which hath this Mythology, that in his Life Time he had made a considerable progress toward the discovery of the *Sun's Annual Course*; but dying immaturally, he left the Theory thereof imperfect. That other of *Bellerophon*, whom Interpreters maintain to have been carried up to *Heaven*, not by a Flying Horse, but a Studious and contemplative Mind, eager in the quest of *Syderal* mysteries. That of *Dædalus*, who indeed, by the same towering Speculations, as by the Artifice of Wings, mounted up to the *Northern* part of *Heaven*; while his less ingenious Son, *Icarus*, falling short in his attempt of imitating his Father's sublime Flight (as not so well understanding the Demonstrations of the reasons of his Theory) flagged very low in his Studies: and fell from the true and apodictical cognition of *Celestial* Motions and vicissitudes: with many other the like re-

counted by *Lucian*; as that of *Endymion*, the favorite of the *Moon*; of *Tiresias*, the Prophet, &c. Yet one thing there is mentioned as well by *Lucian*, as *Tatius*, which we cannot well pass by; which falling under the account of Heroical Times, seems to come somewhat near to that which is called Historical. And that is the notable Contention that arose betwixt *Atreus* and *Thyestes* about supream Dominion. For when by the publick Consent and Vote of the *Argives*, the Kingdom was to be his of the

Two, who should give the most eminent Testimony of Science: it came to *Atreus* share to be King: because, though *Thyestes* shewed them the *Sign Aries*, in *Heaven* (for which he was honoured with a golden *Ram* (yet had *Atreus* declared a thing more excellent; while discoursing about the Variety of the *Sun's* Rising. He made it appear, that the *Sun* and the *World* (i.e. the *Starry Orb*) were not carried the same, but quite contrary Wayes, and consequently, that that part of the *Heavens* which was the *West* or *Occident* of the *Starry Orb*, was the very Rising, or *Orient* of the *Solary*. Hence that Verse of *Euripides*,

Διέξας γὰρ ἀντὶ τὴν ἐναντίαν ὁδὸν

*Qui Astrorum enim contrariam ostendit viam.*

To

To the same Times likewise are we to refer the Institution of *Hercules* and the *Olympick Games*, by *Hercules*; which after a long interruption were renewed by *Iphius*. For, inasmuch as those Sports were instituted for no other end (as may be assured from *Censorius*) but that their Celebration might put men in mind of that *Intercalation* of a Month and half, that was to be made constantly every fourth Year, in respect of those four Times eleven, or forty four Days, by which the Motion of the *Moon* anticipated that of the *Sun*; and the four times six Hours, or one whole Day, by which the circuit of the *Sun* exceeded 365 Days: manifest it is, that *Hercules* could not understand this, without having first exactly Observed the Motions of the *Sun* and *Moon*. Hither also belongs that which is reported of *Orpheus* who must needs have attentively Observed the seven *Planets*. if it be true, as *Lucian* avers, that he represented their Harmony by his *Sevenstringed Harp*: which the *Grecians* thereupon designed in *Heaven*, by some *Stars*, that to this Day retain the name of *Lyra*. So likewise doth what *Sophocles* saith of *Palamedes*, who pointed out the several *Asterisms*, and particularly

Ἀρκτὺς Στερεὰς τε, καὶ κύνων Ἀρκτὺν δόκιν

*Ursum. volutam: gelidum & occiduum. Canis.*

And lastly, what *Homer* recounts, that in those Times were well known (besides *Bootes* and the *Bear*, or *Wain*.)

Πλειάδες, δ' Ὀρσίδας τε καὶ δόκιν Ὀρίωνος  
*Pleiades, atq; Hyades, roburq; ipsum Orionis.*

*Odys. E.*

We have now struggled through the Darknefs of Fabulous Times, and are advanced as far as to discern the Twilight of *Historical*. And here, the first thing we clearly perceive, is that the whole Controversie about the Antiquity of *Astronomical Observations* lies betwixt the *Egyptians* and the *Assyrians*, or *Babylonians*. For, as to the *Grecians*, though some have thought they might put in also for a claim to the Honour of being the Authors of this admirable Science; yet by the Verdict even of *Plato* to himself, they are to lay by the pretence of competition; "For, saith He, The first that made *Syderal* Inspections, was a *Barbarian*; a more Ancient Nation than Ours bred those Men,"

Li

"who

"who first devoted their Minds to that Study, in respect of the  
 "Summer-like serenity and perspicuity of the *Air*, such as *Egypt*  
 "enjoys, and *Syria*, where all the *Stars* are clearly visible, and  
 "no Clouds or Mists to obscure the beautiful Face of *Heaven*.  
 And certainly, if we except what we newly mentioned, the In-  
 stitution of the *Olympick Games* by *Hercules*, and the Restauration  
 of them after some Intermision, by *Iphytus*, which hapned about  
 800 Years before Christ; and some places in the Writings of  
*Homer*, and more especially of *Hesiod*, who lived near upon the  
 same Time, or not long before; we shall find that the *Grecians*  
 can produce no Monuments of their Observations of the *Hea-*  
*vens* more Ancient than those of *Thales*, who flourish'd full 600  
 Years before Christ; and who yet borrowed his knowledge of  
*Aetherial* Matters from *Egypt*. It being manifest therefore, that  
 the *Egyptians*, or their Priests, are the only Men, that ought to be  
 admitted to a dispute with the *Assyrians* or *Babylonians*, or their  
 Philosophers, concerning the Antiquity of Observations, and  
 that their several Pleas seem equally reasonable. Truly, it is no  
 easie matter to determine the difference, so as to place the Law-  
 rel on their Heads to whom it doth of right belong. For, albeit  
*Josephus* assigns the Honour to the *Chaldeans*; and others again  
 stand firmly for the *Egyptians*: yet *Plato*, *Diodorus*, *Lucian*, *Achilles*,  
*Tatius*, and others alledge such quotations for each party, as seem  
 to have no other, but the Authority of the parties themselves.  
 Nor ought that to seem strange; since both sides equally alledge  
 the convenience of their vast Companies, & the Serenity of the  
*Sky*; since they both boast themselves the Original Nation, and  
 allow their Competitors to be only *Colonies*; since both glory in  
 Fabulous beginnings, which we cannot trace or discuss; & both  
 recur to egregious falsehoods about the time when their Ancestors  
 first made *Celestial* Scrutinies. For, the *Chaldeans* (as we find in  
 the Register of *Diodorus*) affirm, that their Nation applied them-  
 selves to these Studies, from Times of incredible Antiquity, viz.  
 of four hundred and 3 thousand Years: And the *Egyptians* (as  
*Cicero* Observes) talk of Observations of four hundred thousand  
 and seventy Years standing. Unless you shall please to consign  
 the Victory to the *Egyptians*, because they put a value on them-  
 selves by Auction. As if it were not enough for them to boast  
 those four hundred nine thousand Years (mentioned by *Laer-*  
*tius*) in which from the Time of *Vulcan*, the Son of *Nilus*, to  
 that

1. Antiq. 8.  
 in Epinome.  
 2. lib. de A-  
 strolog. V. 3. 30g.

Loc. citat.

de Divinat.

that of *Alexander of Macedon*, there happened of *Eclipses* of the *Sun* three hundred seventy three, and of the *Moon* eight hundred  
 thirty two. These Considerations premised, we cannot indeed  
 deny but the *Egyptians* had some Observations, some Ages before  
*Thales* and other *Grecians* Travelled among them: but when we  
 would enquire more precisely into the Time, when those Ob-  
 servations first begun; we find our selves at a loss, and brought  
 back again into the Cimmerian obscurity of Fabulous Times.

Now forasmuch as, though *Pliny* writes, that *Epigenes* found  
 no Observations among the *Babylonians* of above seven hundred *lib. 9. c. 56.*  
 and twenty Years Antiquity, and those engraven on artificial  
 Tiles or Slates; and the most ancient *Eclipses* deduced from them,  
 were transmitted to *Ptolemy*, about the same number of Years be-  
 fore Christ; and that by the great *Hipparchus*. And to the same *in Almagest.*  
 Time belongs what *Berosus* & *Critodemus* say, that in their Days *lib. 4. cap. 6.*  
 there were extant no Observations of more than four hundred  
 and thirty Years, as may be found also in *Pliny*: forasmuch, we  
 say, as we have brought some considerable Monuments of Obser-  
 vations much elder than that Time; yet shall not concede be-  
 yond what the *Chaldeans* themselves profess, when they testi-  
 fied to *Calisthenes* (who went to them upon no other Errand, by  
 the perswasion of *Aristotle*, as *Simplicius* relates) that they had no *in lib. 3. de Cae.*  
 thing of that kind among them beyond a thousand nine hun- *lo, and com-*  
 dred and three Years past: which Years seem to commence at *ment: 46.*  
*Ninus*, the Son of *Belus*, and first King of the *Assyrians*. It is clear,  
 that the Antiquity of Observations ariseth to (but not above)  
 one thousand and ninety Years before *Alexander the Great*.

But, alas! after all this great ado, What did the Observations *Artic. 5.*  
 themselves amount unto? Why truly, for ought we can gather from *Yet neither of*  
 all that is Extant concerning them, those of the *Egyptians* amount *them observed*  
 ed to nothing at all; and those of the *Chaldeans* to very Little. For *any thing consi-*  
 the *Egyptians*, we confess, are said to have Observed the Rising of *derable: as to*  
 the *Dog-Star*, and some other, no very difficult Appearances; but *the designation*  
 we have no Remains delivered down to us, of that or any other *of Times: but*  
 particular they Observed, with the exact designation of the Time *corrupted what*  
 as they ought. And from the *Chaldeans* we have as little, besides *they had obser-*  
 those *Eclipses* mentioned in *Ptolemy*. But when I speak of the *ved, to the In-*  
*Egyptians*, I except *Ptolemy* himself, and some others who Lived and *roduction of*  
 Studied at *Alexandria*, about three hundred years before the Na- *Astrology*  
 tivity of our Saviour; or after *Alexander*: as *Timocharis*, *Erato* be- *Judicial.*

nes, *Hypparchus*: for all these were either *Grecians*, or to be accounted among the *Grecians*, in respect of the Language they used and wrote in rather than among the ancient *Egyptians*, by whose Inventions even *Ptolemy* himself (one of their one Country-men, without dispute) was very little, or nothing at all assisted in his Study of *Astronomy*. But, what concerns as well the *Egyptians*, as *Chaldeans*; their Observations are to be distinguished (according to the division vulgarly received) into (1.) *Astronomical*, and (2.) *Astrological*: the former relating to the Motions, Magnitudes, Distances, and Proportion of the *Stars*; the latter to the Effects of them, which they conjectured were dependent on the Vertues and Influences of Heavenly Bodies, as well in the affections of the *Air*, as in the Actions and Affairs of Mankind. For, both Nations being wonderful prone to Superstition, and surpris'd with excess of Admiration at the *Eclipses* of the *Sun* and *Moon*, when they first beheld them; and Observing ever now and then some *Stars* that moved in Courses contrary to the *West*, they began presently to think, that those Apparences happned not without Natural Causes; and that it remained only on Mans part, to Study how those Events might come to be fore-known which those apparences did portend. Hereupon, having attributed the most powerful Vertue to the five Wandering *Stars* (as *Diodorus* testifieth particularly of the *Chaldeans*) as understanding them to be the Proclaimers of the Will and Purposes of the Gods; because they sometimes Arose, and sometimes Set in various Places of the *Heavens*, because they varied their Magnitude & Colour: therefore they conceived, that they ought to address their Studies and Disquisitions principally to these Varieties. And, because they imagined, that the higher the Place was, from whence they should Observe these Wandering *Stars*, the more clearly and distinctly might they be discerned; they builded Structures of vast Altitude; and particularly that immense Tower at *Babylon*, described by *Herodotus*, from the highest Area whereof (where stood also the Temple of *Belus*) they might exactly Behold and Observe the Rising and Setting of the *Stars*, and other *Syderal* occurrences. They took notice likewise, that those five *Planets* did keep almost the same Course, as the *Sun* & *Moon*; and thereupon they pointed out the *Zodiack*; imagining that there must be some eminent Vertue in that part of the *Heaven*; because all the *Planets* kept constantly to it. And this

loc. citat.

lib. 10.

this *Zodiack* they divid'd into twelve parts, or *Signs*; because the *Moon* run it overt twelve times, and the *Sun* only once in one Year: and according to the number of the Days, during which the *Sun* was in passing through one *Sign*, they distinguished each *Sign* again into thirty parts, which we call Degrees. I shall not recount to you, how they would have Twelve Principal Dieties belonging to these Twelve *Signs*, whereof each had his particular Regiment over his proper *Sign* and *Month* dependent thereupon: nor how they substituted thirty of the fixt *Stars*, to assist the *Planets*, and called them *Councelling Gods*: nor how they placed twelve *Stars* always visible in the *North*, for government of the Living; and as many more in the *South*, always visible, for the government of the Dead, there gathered together, with many other the like Dreams and ridiculous absurdities. But the thing I think most worthy your notice, is, by what rude kind of Artifice they distinguished the *Zodiack* into Twelve *Signs*; as we find it described; concerning the *Chaldeans*, by *Sextus Empiricus*, and concerning the *Egyptians*, by *Macrobius*.

ad Astrolog. 1.  
in Semn. 21.

The manner was this. They took a Vessel with a small hole in the Bottom, and filling it with Water, suffered the same to distil Drop by Drop into another Vessel, placed beneath to receive it; and this from the Moment of the Rising of some one *Star* or other, Observed in one Night, until the Moment of its Rising again the next night following. The Water fallen down into the Receiver, they divided into twelve equal parts, and having two other smaller Vessels in readiness, each of them fit to contain one twelfth part of the Water, they again poured all the Water into the upper Vessel, and strictly marking the Rising of some one *Star* in the *Zodiack*, they at the same Moment gave the Water leave to distill into one of the smaller Vessels, and so soon as that was filled, Observing likewise another Rising *Star*, they put under another small Vessel; and so alternately shifting the small Vessels, they noted, if not in one Night, yet in many, the twelve *Stars*, by which they might discriminate the whole *Zodiack* into twelve equal parts. Now with what Art and exactness these Ancients measured out the *Heavens*, may be conjectured from this one example. I might add another foppery of the *Chaldeans*, from the same *Empiricus*, who relates, that taking it for granted, that the future Fortunes of Men did depend on their particular *Horoscope*, or *Sign* Rising at their Birth; when they had a

mind



ibid. cap. 20.

mind to divine in this Kind, Two of these Wise men agreed together in the Calculation of the Nativity of the Person proposed: the one stood by the Mother in Travell, the other on some high Place near at Hand, & as he that was below gave the Sign, that the Infant was then newly come into the World, the other above took care to Observe the Sign, that was just then newly Risen. But, it will be of more use for us to hear what *Macrobius* tells of the *Egyptians*. They, when they would know the Diameter of the *Sun*, had in readiness a Vessel of Stone, hollowed to the form of an *Hemisphere*, exactly made, with a *Style* or *Gnomon* erected in the Middle, and twelve Horary Lines drawn within: And on the very Day of the *Equinox*, Observing the Moment, when the upper Limbus of the *Sun* first shewed it self above the *Horizon*; they marked that Place on the brim of the Vessel, on which the *Gnomon* cast its Shadow. Then again marking that place, on which the Shadow ended, when the lower Limbus of the *Sun's* body appeared just above the edge of the *Horizon*; they measured the space or distance betwixt the two marks of the Shadows, and found it to be the ninth part of an Hour, or the hundred and eighth part of *Hemisphere*, and consequently the two hundred and sixteenth part of the whole Circuit: and from thence they deduced, that the Diameter of the *Sun* was the two hundredth and sixteenth part of its whole Orb; (which, in truth, is the 700th neer upon) or did contain one Degree and an hundred Minutes; which yet is no more than half a Degree, or 31. Minutes, at most. To this we might super-add, that it was the practice of Elder Times, to commensurate the Diameter of the *Sun* by an *Hydrologie*, or Vessel of *Water*; collecting the same from part of the *Water* flowing down the whole Day, which had dropped until the *Sun* was wholly Risen; as is insinuated by *Plutarch*, and deduced from *Capella*: but *Cleomedes* hath at large declared, that this way of Measuring by *Water* falling slowly and equally from Vessel to Vessel, was an Invention of the *Egyptians*. Now the reason, why we touch upon these particulars, was only to satisfy, that (as we said afore) no great matter in *Astronomy* was ever Observed either by the *Egyptians*, or by the *Babylonians*.

And, if you desire any further Argument thereof; Pray take this. They were very far from suspecting, that the Fixt Stars had any Motion proper to themselves; or that they had any Eccentricity

tricity (excepting only that the *Egyptians* thought *Venus* and *Mercury* to Move round about the *Sun*, as their center; as is affirmed by *Macrobius*, and some others) or that the *Sun* had any *Apogeeum* at all; with many other Particulars fully as considerable. Which doubtless must be the Reason, why they invented no *Hypotheses*, by which they might regulate themselves, in making their Calculations of the various Motions of the Heavenly Bodies. And *Peter Ramus* not long since complained that we have not our *Astronomy* free from the trouble of *Hypotheses*; such as the interpreters of *Aristotle* themselves, and *Proclus* on *Timeus* have recorded the *Egyptians* and *Babylonians* to have had amongst them: while, introth, he complained, that we had not our *Astronomy* as rude, wild and imperfect, as theirs was. For, however some *Hypotheses* are more simple (and so more easy) than other some, yet it is absolutely impossible, that *Astronomy* should consist without some or other. Hereupon, they could Observe, indeed, that the Planets were one while Direct in their Progress, another while Retrograde, and then again Stationary; that they in their Wanderings sometimes inclined towards the North, and sometimes deflected again towards the South: but all that while, they could neither comprehend the Reasons of those various Apparences, nor Calculate them by Numbers. The most they could do, was darkly to represent those Motions, by certain *Hieroglyphicks*, as in particular by the Windings and flexures of Serpents; and the Motion of the *Sun*, only by a Beetle rowling his pill of Dung backward: as we may read in *Clemens Alexandrinus*: and then came *Eudoxus*, who having learned the variety of Motions among them, was the first who invented *Hypotheses* of various Orbs, for the Solution of the *Phenomena*.

Again, they were very far from attaining the determinate Places of the Fixt Stars, according to *Longitude* and *Latitude*; or according to their *Right Ascension*, and *Declination*: so that neither could they define the true Places of the Planets, by Comparison to the Fixt Stars, nor (consequently) designe any Observations with due exactness. And truly this was the Cause why *Hyparchus* met with no Observations, either of the *Egyptians* or *Babylonians*, by which he could receive the least help or advantage, toward his composing either *Hypotheses*, or Tables to represent the Motions of the Five Errant Stars: and *Ptolomy* was the first, who partly by the benefit of Observations left



left him by *Hipparchus*, and partly by those he made Himself, became able to attempt such a Work; as stands recorded in his *Almagest*. There were only the *Eclipses*, which both these Nations had set down, as Observed in their Commentaries: and those only so, as that from Past, they might be able to conjecture something of that were to Come. Not from the Motions of *Sun* and *Moon*, exactly Calculated by the help of *Tables*; but having learned from common experience, that every nineteenth Year, *Eclipses* did return again upon the same Day, for the most part: thereupon they endeavoured to prædict what *Eclipses* would happen, and the Time when; and this after they had perceived not any *Anomaly* in the *Sun*, but some certain Inequality in the *Moon*, which reducing to a medium, they concluded that the *Moon* did every Day run through thirteen Degrees, and a little more than one sixth part of a Degree; as *Geminus* delivers of the *Chaldeans*. But in their Predictions of *Lunar Eclipses*, they were somewhat more confident; as well because these *Eclipses* usually return, for the three Ages next succeeding, within the compass of the same Days; as because it is very rare, in respect of the greatness of the *Earth's* Shadow, but the *Moon*, either in the whole, or some part of Her, more or less falls into it: but, because (as to *Solar Eclipses*) the *Moon* is both so small, and hath so large a *Parallax*, as that she doth not for the most part intercept the Light of the *Sun* from the *Earth*: therefore was it (as *Diodorus* witnesseth specially of the *Babylonians*) that they durst not determine *Eclipses* of the *Sun* to come, to any certain Time: but if they predicted any, with limitation of Time, they always (to save their credit in case of failing) annexed this Condition, *If the Gods be not prevailed upon, by Sacrifices and Prayers, to avert them.*

Truth is, these *Astronomers* were also Priests, and it was their interest to cast in this Proviso. For, being ambitious to be reputed interpreters of the Will of the Gods to the People, and so both knowing in things to Come, and skillful in such Ceremonies, wherewith their respective Deities were most attuned and delighted: unwilling to be thought able to predict nothing, and as unwilling again to be found erring in their chief Predictions, they wrapt up all in mysteries, and amused the Vulgar with superstitious Opinions and rites. The *Egyptians*, in a great part of their Sacred Worship, had recourse to the *Astrological Books* of

of their *Mercurius* (one of the Order of the Fixt Stars; a second of the Conjunction of *Sun* and *Moon*; a third and fourth, of their rising) which with what Ceremonious Pomp they used to carry about with them, in a kind of solemn Procession, you may find amply described by *Clem. Alexandrinus*. Nor is it <sup>lib. 6. Astro. mat.</sup> strange that those Priests accounted so Sacred and Knowing, should also be esteemed for Prophets. Further, you meet with no mention of the Five Errant Stars, all this while; and the Reason seems to be, because they attributed an energie of them only as they were referrable to the Inerrant or Fixt: and particularly, as they possess this or that part of some Sign in the *Zodiack*, and together with it had their Rising, or Setting. For, so much did they ascribe to the *Zodiack*, as that the *Babylonians*, and (in imitation of them, the *Persians* and *Indians*) thought, that each decimal of Degrees, or Thirds of the Signs (and the *Egyptians* came as low as to each single Degree) could not be varied in the Rising, but some eminent variation must happen, especially in him, who should be born at that Time. And hereupon was it, that the *Egyptians* made that great Circle of Gold (described in *Diodorus*) of a Cubit in thickness, and three hundred sixty five cubits in Circumference (plundered at last by *Cambyfes*) that upon each cubits space might be inscribed each Day of the Year, 365 Days in the whole round, and also what Stars did Rise, what Set upon each Day, nay the very Hour of their respective Rising and Setting, and what they did signifie: and whereas others used to assign the form of some Animal or other, to each ten Degrees; they assigned one to each single Degree, and so made their Hariolations or conjectural Predictions accordingly. For Example; to the first Degree of *Aries* they assigned the figure of a Man, holding a Sickle or Hook in his right Hand, and a Sling in his left; to the second, a Man with a Dog's head, his right Hand stretcht forth, and a Staff in his left; and so of the rest: then annexing the signification to each, they determined, that he, who should have the first Degree of *Aries* for his *Horoscope*, should be some part of his life a Husbandman, and the rest of it a Soldier; that he, who should be born under the second, should be contentious, quarrelsome, and envious; and so of the rest, all which *Scaliger* hath fully deduced from *Aben Ezra*. In a Word: what ever knowledge either the *Egyptians* or *Chaldeans* had of the Stars, certain it is, they referred it wholly to

*Astronomantie*, or Divination by Stars : and therefore among them there flourish, no true and genuine *Astronomy*, but a spurious and false one, i.e. *Astrology Divinatory*, or the fraudulent Art of Fortune-telling by the Heavens.

lib. 9. cap. 7.  
lib. 7. cap. 37.

2. de divinat.

in Epinom.

*Berosus* (whom we formerly mentioned) coming into Greece, a little after the death of *Alexander*, is discovered to have brought with him nothing solid touching *Astronomy*, but only Judicial *Astrology* for which, as a thing new, and strange to the People, he was highly esteemed, as *Vitruvius* and *Pliny* remark. And *Eudoxus*, who had returned out of Egypt before that, well knew what sort of *Astrology* this was (the principal Contrivers and Founders of which are said to have been *Petofiers*, *Necepsus*, *Esculapius*), but he highly contemned it, as *Cicero* remembers, and brought home no other Fruit of his tedious Travels, besides a list of some Eclipses; and the varieties of the Motions of the Wandring Stars, by which he first essayed to compose accommodate *Hypotheses*, as we have formerly hinted. Nay, *Plato* himself, who was Companion to *Eudoxus*, for thirteen Years together, in Egypt, profess, that he could attain nothing solid and satisfactory, touching those Stars, and therefore placed all his hope only in the sagacity and industry of the Grecians, such as he knew *Eudoxus* to be. "For, having first recounted what ever he knew concerning them, he saith, it is to be believed that the Grecians make more perfect whatsoever they receive from Barbarians; and therefore it is fit, we allow the same, touching the argument of which we have discoursed. Truth is, it is difficult to find out the way, how all these Apparences, so involved in obscurity, may be explicated: nevertheless, there is great hope that things of that sort will be better and more advantageously handled, than they were delivered to us by Barbarians.

Articl. 6.

And after them to the Grecians; among whom the most ancient mention of *Astron.* is in *Hesiod*.

From the Egyptians and Chaldeans, therefore (as *Astronomy* Her self, while young and rude) we come to the Grecians; and the most Antique Record of Syderal Observations to be found among them, seems to be that of *Hesiod*; who in his Book of Weeks and Days teacheth Husbandmen the most opportune Times of Reaping, Sowing, and other Labours of Agriculture, from the Rising and Setting of the *Pleiades*, and *Hyades*, and *Arcturus*, the Dog-star, and *Orion*:

Πληιάδων Ἀρκτουρίου ἐπισηλλομεν αἶων.

Donec Pleiades, quæ & Atlantides, exoriantur, &c.

And

And I cannot tell, whether it were that Book, or some other, that *Pliny* meant, when speaking of *Hesiod*, he says, *Hujus quoque nomine extat Astrologia*, there is extant an *Astrology* of his. However, we are here to remark two Things, in order to our more exact disquisition; the First is, that the Ancient Greeks principally attended to these Risings and Settings, as well that they might distinguish the several Seasons of the Year, as that they might fore-know Rain, Wind, and other dispositions of the Air, usually attending these Seasons. And hereupon, *Thales*, *Anaximander*, *Democritus*, *Eudemus*, *Meton*, *Eudoxus*, and many others, composed certain *Paraegmata*, Tables (as *Ephemerides*, or *Diaries*) in which they inscribed each Day of the Year, with the particular Stars Rising or Setting on each Day, and what Mutations of the Air each one did portend. Such a *Paraegme* as these, was composed likewise by *Julius Cæsar* himself, for the Horizon of Rome; in allusion whereto he might justly own, what *Lucan* said for him,

Ex. Gem. Prot. & alius.

lib. 10.  
lib. 1.

*Nec meus Eudoxi fastis superabitur Annus.*

And, him doubtless, did *Ovid* translate into his *Fasti*; promising in the beginning, that he would sing of the Stars and Signs, that Rose and again Descended under the Earth. But, to keep close to the Grecians; among them, he was held a great *Astrologer*, who had discovered and Observed only these Risings and Settings here spoken of; and so of whom that might be spoken, which *Catullus* said of *Conon*,

*Omnia qui magni dispexit lumina Mundi,  
Stellarumque ortus comperit, atque obitus.*

For, before the Advent of *Berosus*, this was the only [*Episemasia*] Præsignification or Devination by the Stars, the Grecians had among them: unless what *Hesiod* hints, in his

in diebus,

Πρώτων ἔτη τε τίς τε, καὶ ἐδόμην, ἱερὸν ἡμῶν.  
*Primum prima Dies, & quarta & septima Sacra, &c.*

where he points out, what Days of the Moon were accounted Lucky, and what Unlucky.

K k 2

The

The *Second* Observable is; that among the *Grecians*, and indeed among divers other Nations, beyond all Memorials of either Traditions, or Books, the *Stars* were reduced to certain Images or *Constellations*, and denominated accordingly (as their Names yet shew) as it pleased the fancies of Husbandmen, Shepherds, Mariners and the like, who used to be vigilant and gazing upon the *Heavens* in clear Nights. Though there have been some *Constellations* added of latter Times, as that of the

Lib. 1. de vit. Lesser Wain by *Thales*, which *Laertius* and *Tatius* recite out of  
Isagog. de Com. *Calimachus*, who also took the same elsewhere, and that of *Be-*  
Beren. *renices Hair*, removed into *Heaven* by *Conon*, as *Catullus* relates.  
lib. 2. Astron. *Cleostratus* likewise (as we have it from *Hyginus*) found out the  
lib. 2. cap. 1. *Kids*: though (which *Pliny* moreover attributes to him,) his

in 1. Georg. l. 8.

invention of the *Signs* in the *Zodiack*, is to be understood, as that he taught Men through what *Signs* the *Sun* and other *Planets* passed. But (that we may touch also upon this) at first the *Grecians* had only Eleven *Signs* in their *Zodiack*; and it was Long after ere they came to add the Twelfth, in imitation of the *Egyptians*, who (as may be collected from *Servius*, *Marcianus*, and others) in stead of the *Claw* of the *Scorpion*, placed *Libra*, the place destined to *Augustus*, by *Virgil*,

1. Georg.

---Ipse tibi jam brachia contrahit ardens *Scorpius*:---

They added the Twelfth, we say, to the end, that as the whole Compass of the *Zodiack* was divided into *Dodecatemoria* (as they call them) twelve equal Parts, so it might consist also of Twelve *Signs*. Albeit, being (as it were) necessitated to make use of such *Signs*, as had been brought up, rather by chance, than Art; those twelve *Signs* were not exactly proportionate to the twelve Divisions of the *Zodiack*, but took up more space some, than others: as in particular, *Leo* possesseth more room than *Cancer*, *Taurus* than *Gemini*: I say, than *Gemini*, which though composed of *Castor* and *Pollux*; in so little space as is allowed them, it is impossible the one should Rise, when the other Sets, and both in the *East*: but this *Empericus* interprets of the two *Hemispheres*. I omit to insist upon this, that all Nations had not the same *Constellations*: as among the *Egyptians* was no *Bear*, no *Cepheus*, no *Dragon*, but other Forms or Representations, as *Tatius* reports; and shall add only, that *Eudoxus* seems to

1. Advem. Physic.

to have been the first, who partly out of the *Egyptians* Figures, partly out of the *Grecians*, finished the whole *Zodiack* with Images resembling the *Asterismes* (as Men had fancied, at least) and caused them to be drawn on a *Globe*, or solid *Sphere*. For, *Aratus* (upon whose Poem, intituled *φανόμενα*, *Appearances*, there have been so many Commentaries set forth, as that no fewer than forty have been extant in *Greek*, besides those of *Cicero*, *Germanicus*, *Avienus*, and other *Latin* Interpreters) did no more, but only express in Verse, what *Eudoxus* had said before in Prose, of this Argument; as *Hypparchus*, *Bythinus* demonstrates. I know not whether it would be seasonable for me, here to advertise, that it is no wonder *Aratus* erred so grossly in many particulars; considering that (as it is written in his Life) he Living with *Antigonus Gonata*, in the quality of his Physician, and *Nicander* in the quality of his *Astrologer*, and both were good at Poetry: *Antigonus* commanded the Physician to give him a trial of his Poetic, upon an Argument in *Astrology*; and the *Astrologer* to give another of his, upon something in *Physick*: delivering to the one, the Book of *Eudoxus*; and to the other, all that was extant of *Treacles*, *Antidotes*, or *Counter-poisons*. So each Wrote of what he did not well understand. One thing I shall not forget; and that is, that the *Phenomena* of *Euclid*, who Lived near about the same Time, and taught at *Alexandria* (as in the Memorials of *Pappus*) were quite of another kind, being indeed no other, but certain Principles of *Astronomy*, concerning the Figure of the *World*, and the Circles of the *Sphere*, and chiefly, that of the *Zodiack*.

Lib. 1. in Arat. Phen.

lib. 7.

But, to return back to the more Primitive *Greeks*, I remember I said, that *Thales Milesius* was accounted the First, who after old *Hesiod* and *Homers* Days, enquired into the Order of the *Stars*. And certainly he was the Man, who among the *Grecians* may challenge the Palm; as to Antiquity; for, *Apuleius* calls him, *ut antiquissimus, sic peritissimus Astrorum Contemplator*, and *Eudemus* in *Laertius* attesteth, that this was the Opinion of most, adding moreover, that *Xenophanes* and *Herodotus* highly admired him, for that he had first predicted the *Eclipses* and Conversions of the *Sun*; and that *Heraclitus* and *Democritus* witnesseth as much. And whereas *Apuleius* further subjoins, that he found out the Motions and Oblique Tracts of the Syderal Lights, *Pliny* ascribes that to *Avaximander*,

And next of  
Thales Mile.  
sus.

lib. 1.

der, a Disciple of *Thales Milesius* (whence he was said *Rerum fores aperuisse*, to have opened the Doors of *Cælestial* Matters) and *Diodorus* to one *Oenopides Chius*: which *Thales* could not yet be ignorant of the Obliquity of the *Zodiack*, when he had written of the *Solstices*, and *Equinoxes*, and had conversed a long Time with the *Egyptians* in their own Country, as *Laertius* remembers. Further it is delivered to us, that among others, he predicted that notable *Eclipse* of the *Sun*, which hapned in the Time of the War betwixt the *Medes* and *Lydians*; which he could not do by any other Reason, but only because, coming newly out of *Egypt*, he had learned, that *Eclipses* generally return upon the same Day after the space of nineteen Years, and having taken notice of one that fell out nineteen Years before, he concluded that there would be one at such a Time. Nor is there Reason why any should think, that otherwise his whole Life might be sufficient to Observe all the Motions of the *Sun* and *Moon*, as from thence to be able to invent all things necessary for the Calculation of Times of their several *Eclipses*. Moreover, it doth not appear, how by any other way, but that *Helicon Cyzicenus* came afterward to foretel that *Eclipse* of the *Sun* (mentioned in *Plutarch*) for which he was so much admired by *Dyonisius*, and rewarded with a Talent of Gold. Nor likewise, how *Sulpitius Gallus* could foretel that other of the *Moon*, which as most opportunely predicted to the *Roman* Army, then ready to joyn Battel with the *Persian*, is so highly Celebrated not only by *Plutarch* and *Pliny*, but also by *Valerius*, *Quintilian*, and other *Historians*: for other Rule for the Calculation of future *Eclipses*, there was none before *Hipparchus*, who invented Hypotheses and Tables fit for that purpose. Besides, what *Laertius* imputed to *Anaximander*, *Plinius*, as confidently imputes to one *Anaximenes*, an Auditor of his: (namely that he should be the Inventor of that *Gnomon*, by which the Conversions of the *Sun* or the *Solstices* and *Equinoxes*, were indicated; and that he set up such a one at *Lacedæmon*.) Near upon the same Time was it, that *Pythagoras* is said to have first discoursed (though *Phavorinus* in *Laertius*, confers that Honour upon *Parmenides*) that *Lucifer* and *Vesper* was one and the same Star of *Venus*. Now, whether may we conceive, that he borrowed this of the *Egyptians*, from whom being taught, that not only *Venus* but *Mercury* also were carried round about the *Sun*, as their Center, so that one and the same might

In act. Dionys.

Hen of Pythagoras, and his Disciples.

might be both *Morning* and *Evening-Star*: possibly, from thence he might take the hint of his Conjecture, that the *Sun* was the Center of not only those two, but of the other *Planets* also, and consequently of the whole *World*: and Moreover that the *Earth* it self, as one of the *Planets*, moved about the *Sun*? For truly, this was an eminent and constant Tenent in his School; as may be understood, not only from *Aristotle* in the general; but also from *Laertius*, in particular of *Philolaus*, and from *Archimed.* of *Aristarchus*, both *Pythagoras* his Disciples: that we may not rehearse all those many passages in *Plutarch*, concerning this Memorable particular; nor name those, who held; that the *Earth* was not so much moved about the *Sun*, as daily turned round upon an *Axis* of its own; as *Timeus*, a *Pythagorean* also, who is therefore by *Synefius* esteemed, after *Plato*, the most excellent *Astronomer*.

2. de celo. 13.  
de Arctur-  
num.Philolaus.  
Aristarchus,  
Timeus,  
De don ad pa cu.  
in Timæum.

Furthermore, in the next Age after *Thales*, or near upon, comes *Cleostratus* (the same who was believed to have deprehended the *Signs* of the *Zodiack*) and he, seriously remarking that the *Intercalation*, which as we said, was wont to be made every fourth Year, celebrated with the *Olympick Games*, did indeed restore the Motion of the *Sun* to the same Day again; but did not restore the Motion of the *Moon* till the eighth Year, or two *Olympiades*, in which the *Intercalatory* Days amounted to ninety Days, or three months: He, we say, thereupon interduced, instead of the *Tetaeteris*, or space of four Years, the *Ostaeteris*, or space of eight Years, which compleatly past, the *New-Moons*, and *Full-Moons* would return again on the same Days. But, when in short Time men had perceived, that this Institution failed them, in exactness of Computation; and that sundry waies had been attempted to cure this uncertainty, at length riseth up *Meton*, somewhat more Antient than *Eudoxus*; and he demonstrateth from the *New-Moons*, and *Full-Moons* *Egyptical*, that they did not return upon the same Days, till after full nineteen Years: and thereupon he became the Author of the *Ennea decaeteris*, or *Period*, or *Cycle* of nineteen Years. In respect of which Discovery, together with the *Heliotrope*, or *Sun-Dial* he made at *Athens*, and some other the like Inventions, he was in eminent esteem among the *Athenians*. But as concerning that *Period*, *Callippos*, familiarly acquainted with *Aristotle*, discovering it to be too Long by the fourth part of a Day; inferred that from four *Periods* one whole Day

After these suc-  
ceeded Cle-  
ostratus.

Meton, &amp;c.

Day ought to be detracted: and so erected a new *Period* or *Cycle* of Sixty six Years, or four times nine; at the end of which, one Day was to be cut off; and this was called the *Callippick Period*, and remained in Use for a long time together. After him, succeeded *Hipparchus*, who detecting this *Period*, to be yet too Long; demonstrated that after four *Callippick Periods*, or three hundred and four Years, there would remain one whole Day too much. And in truth, the Experience of many succeeding Ages declared, that to this detraction of *Hipparchus*, nine or ten Years over and above were to be expected. However, it is worthy our Notice, that the *Period* of *Meton*, together with the Connection of it, applied by *Callippus*, was of long use in the Church, under the name of the *Golden Number*: though wanting the Application of *Hipparchus* his Correction: also, a mistake about of four Days, relating to the *New* and *Full Moons*, crept into the Account, even from the Time of the *Nicene Council*, which was one of the two main Causes of the Reformation of the *Kalendar* in the eighty second Year of the last Age.

Artick. 7.  
Eudoxus, who  
first discovered  
the necessities of  
manifold  
Spheres.

And now we have an opportunity to speak more expressly of *Eudoxus*, so frequently mentioned. This man, well understanding after his Return out of *Egypt*, that not only the *Sun* and *Moon*, but also the five Errant Stars, did keep their Courses round in the *Zodiac*; and so, as that as well the *Sun* and *Moon*, as those wandring Stars did sometimes vary their *Latitude*, or deviate from the *Ecliptick* Line in the middle of the *Zodiack*: (for, he thought the *Sun* was also extravagant, as well as the rest;) and again, that the other *Planets* did not only go forward, but were also sometimes upon their Retreat backward; and sometimes made a Hault or stood still: we say pondering all those various Motions in his Mind, and casting about what might be the Reasons thereof in Nature; he at last imagined to himself that besides the *Aplanes* or *Sphere* of fixt Stars, which being supream, carried all the rest toward the *West*, there ought also to be allowed three other *Spheres*, as well to the *Sun* as to the *Moon*, and four to each one of the other Errant Stars, of which one and that the Highest, should follow the Impression of the *Fixt Stars*, or rather of the *Primum Mobile*; the next to that should move Counter to the First, or toward the *East*; the third makes the deviation from the *Ecliptick*, or middle of the *Zodiack*; and the fourth, or lowest, cause in the Stars their *Direction*, *Station* or *Retrgradation*, and that by

by a certain Vibration, or Waving to and agen. So that he supposed in all, twenty seven *Spheres*, and all those Concentrical, that the Superior might carry on the Inferior, and these might be turned round within those. Afterwards *Callippus* adjoyned two *Spheres* to the *Sun*, two to the *Moon*, and one a peece to *Mars*, *Venus*, and *Mercury*; and so made thirty three: And *Aristotle*, to all the *Spheres*, which did not follow the Motion of the *Aplanes*, or *Primum mobile* (excepting only the *Lunar Spheres*) added as many more, which he called the *Revolvent* ones, to the end he might conform them to the Motion of the *Inerrant Sphere*, or *Primum mobile*: and so in the whole he constituted Fifty six *Spheres*, forasmuch, at least as we can collect from his own context. Now all these, and even *Plato* himself likewise, thought that the *Moon* was the lowest of all the *Planets*; next to her, the *Sun*: and above the *Sun* the five Wandering Stars: Nor indeed doth it appear, that *Archimedes* himself Living a whole Age or two after them, represented the *Planets* in any other, than this very Order, in that so famous *Sphere* of his. In which though *Claudian* tells us, that no more was represented, but only the Motions of the *Sun* and *Moon*;

*Percurrit proprium mentitus Signifer annum,  
Et simulata novo Cynthia mense redit:*

In Epigram

Yet *Cicero* adds other Motions, when speaking of *Archimedes*, "he saith; when he Collected together the Motions of the *Moon*, *Sun*, and five Wandering Stars, he did the same as that God, who in *Platoes Timæus* framed the *World*, that one and the same Conversion might regulate sundry Motions, most different each from other in Slowness and Swiftnes. But *Hypparchus* afterwards finding, that as well the *Sun* as the *Moon* and the other five Stars, did come sometimes neerer to the *Earth*, and sometimes again mounted up farther from it; and plainly perceiving that that particular Apperance could not possibly be explicated by those *Spheres*, that were all Concentrical to the *Earth*: therefore, wholly rejecting them, he resolved, that the Motions of the *Planets* were to be accounted *Eccentrick*; and though he could not himself determine each particular, he yet demonstrated the Way, in which *Ptolomy* afterwards inslitting, accomplished,

De divinaz.

the Invention. But before we advance further, we are to Commemorate two or three Persons of Note, by whose Observations both *Hypparchus* and *Ptolomy* profited very much. One was *Timocharis*, who about three hundred Years before Christ, among other things relating to the Fixt Stars, Observed that that Star which is called *Spica Virginis*, doth antecede the point of the Autumual Equinox, by eight Degrees. And with him are we to joyn *Aristillus*, whose Observations of some thing about the Fixt Stars *Ptolomy* made great Use of, in order to his demonstrating that the Fixt Stars never change their Latitude. Afterwards (scarce an Age) succeeded *Eratosthenes*, who being Library-keeper to *Ptolomy Evergeta* the former, perswaded him to set up the Armille in the Porticus of Alexandria; which *Hypparchus* and *Ptolomy* afterwards made Use of; and himself among other things Observed, that the Obliquity of the Zodiack was of twenty three Degrees, and fifty one Minutes; which account *Hypparchus* and *Ptolomy* constantly adhered to.

*Ptolom. lib. 1. cap. 11.*

Articl. 8.  
*Hypparchus, who first observed the places of the Fixt Stars, according to Longitude and Latitude.*

*lib. 2. cap. 23.*

Now that we may at length remember the great *Hypparchus*, who flourish't neer upon an hundred and forty Years before Christ: truly, we find it no easy task to recount, how highly Astronomy was beholding to him. For, in the first place, Examining that foresaid Observation of *Timocharis*, with some others, albeit he could not conceive them to be in all points exact, yet because himself had found that *Spica Virginis* did not antecede the Equinoctial Point by more than six Degrees, and the other Stars in the like proportion: he hence understood, that the Fixt Stars also were moved Eastward according to the Zodiack; and thereupon wrote a Book, of the Transgression of the Solstices and Equinoxes. And, being that in his Time, as not long ago in Tycho Braches, there appeared a certain New Star, he "therefore came to doubt (to speak the Language of *Pliny* concerning him) whether the like happened often or not; and whether those Stars, that were thought to be fixt, had also some certain Motion peculiar to themselves. Wherefore (as the same *Pliny* goes on) he attempted a task of difficulty sufficient even for the Gods themselves; namely to number the Stars for Posterity, and reduce the Heavenly Lights to a Rule, so that by the help of Instruments Invented, the particular Place of each one together with its Magnitude, might be exactly design'd: and whereby men might discern, not only whether they disappeared,

"peared, or newly appeared, but also whether they Removed their Stations; as likewise, whether their Magnitude Encreased, or Diminished; Leaving Heaven for an Inheritance for the Wits of succeeding Ages, if any were found acute and industrious enough to comprehend the mysterious Order thereof. And this was the first Time when the places of the Fixt Stars were Observed and markt out according to Longitude and Latitude: and that Catalogue of the Fixt Stars, which he Composed, is the very same, which *Ptolomy* afterward inferred into his *Almagest*. In the next place, He denoted what positions sundry Stars had in respect each of other: whether they were posited in a right Line; or in a triangular Form; or in quadrate or square, &c. As is manifest even from *Ptolomy* himself. Further though the Motions of Sun and Moon were already in some measure known; yet he made that knowledge much more exact. For, he did not only much Correct the Callippick Period, formerly spoken of, but also, having Collected a long Series of Eclipses (namely, from the Time of those Babylonish ones, in the Days of *Mardacempades*, down to those Observed by himself, for full six hundred Years together) and remarking, that neither the like Eclipses did Return on the same Days, after the space of every nineteen Years, nor that after some recourses of ten Novennales, or ten times nine Years, any such Eclipses happened at the times supposed; and that the Cause thereof consisted both in the various Latitude of the Moon, and the Anticipation of her Nodi or Knots, and her Eccentricity, by reason whereof her Motions to her Apogee were found to be sometimes slower, and those to her Perigee more Speedy: therefore, we say, He comprehended and gave Reasons for all these Difficulties, and composed certain Hypotheses, and according to them, certain Tables, by which he could safely and exactly Calculate and Predict what Eclipses were to follow, how great they were, and when. And this was it which *Pliny* remembred, when having spoken of *Thales*, and *Sulpitius Gallus*, he comes to mention *Hypparchus*, "After these (saith He) *Hypparchus* foretold the Courses of both Luminaries, for six hundred Years to come; comprehending the Months, Days, and Hours of Nations, and the Situations of Places and turns of People: his Age testifying that he did all these great things, only as he was partaker of Natures Counsels. For, it must be that *Hypparchus*, besides the precise Times, when

*lib. 7. cap.*

*ibid. cap. 1.*

*He also corrected the Callippick Period, and predicted future Eclipses for 600 Years together.*



such *Eclipses* were to be Visible to the *Hor.* of *Rhodes*, or *Alexandria*, pointed forth also some Countries, and principal Cities, together with the Designation of the Months in use among them; as also the very Days and Hours when each *Eclipse* would happen; and other Predictions succeeding to *Rome*, in the Days of *Pliny*.

Again, it is well worthy our recital, that *Hypparchus* labouring with long Desire both to constitute *Hypotheses*, and reduce into Tables the Motions of the other *Planets*, or five Wandering *Stars*; and yet not being able to furnish himself either from the *Egyptians*, or from his Country-men the *Grecians*, with any competent Observations respective to those *Planets* (for while the places of the Fixt *Stars* remained unknown, it was impossible any such could be made) and again those he had himself made, were of much shorter Time, than was requisite for the establishing any thing certain and permanent in that sort: He therefore only digested such Observations as he had recorded by him into the best Order and Method he could devise; and so left them for their Use and Improvement, who should come after him, in case any were found capable of understanding and advancing them. And at length, by good Fortune, it so fell out, that those his Observations came into the Hands of *Ptolomy*; who, comparing them with his Own, and finding them Judicious and Exact, thereupon first began to erect both *Hypotheses* and Tables of Motions fit for those *Planets*: yet not without much timorousness and diffidence; because his Observations being but few, nor of sufficient Time, he durst not promise himself any certainty of his Tables for any considerable Spaces, or number of Years. But for more assurance let us hear his own ingenious

*Almagest*, lib. 1.  
cap. 2.

Confession in that point, "The Time (saith He) from whence we have the Observations of the *Planets* set down, is so vastly short in comparison of the greatness of *Cælestial* vicissitudes, as that it renders all Predictions, that are for any great number of Years to come, infirm and uncertain. And therefore I judge that *Hypparchus* (that zealous lover of Truth) considering this difficulty, and withal receiving not so many true Observations from the Ancients, as he bequeath'd to us, undertook indeed the business of the *Sun* and *Moon*, and demonstrated that it might be performed, by Equal and Circular Motions: yet, as for that of the *Planets*, those Commentaries of his, which have come into our Hands, clearly shew, that he attempted

"tempted it not: but collecting all his own Observations concerning them, together in one order and method, for their more commodious use, resigned them to the industry of after Times, having first demonstrated, that they were not congruous to those *Hypotheses*, which the *Mathematicians* of those Days made Use of. And, for others, sure I am, that either they demonstrated nothing at all, or else only attempted the business, and left it unfinished. But, *Hypparchus* being eminently knowing in all kinds of Learning, conceived, that he ought not (as others had done before him) to attempt; what he should not be able to accomplish. So that we see, *Ptolomy* was the first, who from true Observations, reduced the Motions of the *Planets* into *Hypotheses* and Tables correspondent.

But before we speak more particularly of him, who Lived about an hundred and thirty Years after Christ; forasmuch as in the space of Time betwixt *Hypparchus* and *Ptolomy*, these Studies so Flourish'd at *Alexandria*, as that *Julius Cæsar* returning thence, brought along with him that *Soligenes*, by whose Assistance he endeavour'd the restitution of the *Calendar*; and so may be thought to have propagated the Study of *Astronomy* among the *Romans*: Let us reflect a little upon that Time, and see what care they then had of *Cælestial* Matters. In the first place, We are to lay aside the Commemoration of *Sulpicius Gallus* (of whom more than once afore) as one that falls not under this account, concerning whom we may not yet forget, what *Cato* is induced by *Cicero*, saying, While we saw that *Gallus* Dye, that Familiar Friend of thy Father, O *Scipio*, who was restless in Measuring *Heaven* and *Earth*; I say, while we saw him Dying even in that Study; How often did Day oppress him, when he had set himself to Observe and describe something in the Night? and how often did Night oppress him, when he had begun his Speculations in the *Moon*? How was he delighted, when he had a long Time before predicted to us *Eclipses* of the *Sun* and *Moon*? &c. For he was a Man clearly singular, and in an Age when so great Ignorance and neglect of good Arts tyrannized over Mens Minds, being himself Studious and inquisitive, could not but have borrowed his Skill either from *Egypt* or *Greece*, where having obtained a Series of *Eclipses*, and the Way of deducing them through the Circuit of nineteen Years (as we said before) he became able to Calculate them, so as *Cicero* relates. For, as to the rest; how great

Articl. 9.  
Betwixt Hypparchus and Ptolomy, came Soligenes, of Alexandria, by whose help Jul. Cæsar, endeavour'd the reformation of the Calendar.

do



do you think was the ignorance and neglect, nay even Contempt of Studies of this Nature among the *Romans*? Why truly so great, as that *Virgil* could not dissemble it, in the Poësy attributed to *Anchisa*; according to which the *Romans* should indeed come to Rule the *World*; but yet should yield to others in Learning to know the *Stars*, and describe the *Heavens*.

6. *Encl.*

—Cæliq; meatus

Describent radio, &amp; surgentia sidera dicent.

lib. 2. cap. 28.

1. Meteor. 7.  
Pythias Massiliensis, a Gaul and contemporary to Alexander of Maced.

lib. 7. cap. 60.

And *Cato* himself is cited by *Agellius* to have left in Writing, that it was not Lawful to Write what is in a Table kept by the High Priest: How often scarcity of Provision would happen; How often the Light of the *Sun*, or *Moon* should be Darkned: so far, saith *Gellius*, did *Cato* condemn the Science of *Astronomy*, and thought useless either to know, or foretell the *Eclipses* of *Sun* and *Moon*. Furthermore, though from Times as high as *Numa*, the *Romans* made several Intercalations; yet they took all their Art of that sort, from the *Greeks*: and *Pliny* remarks, that in *France*, *Spain* and *Africa*, there was not one Man, who could so much as tell the Rising of the *Stars*. Nevertheless we are not to forget, that among the *Gauls* was one *Pythias*, the *Philosopher* (as *Cleomedes* calls him) of *Massilia*: who about the Time of *Alexander* of *Macedon*; found the Proportion of the *Gnomon* to the *Solstitial* Shadow, to be the same at *Massilia*, as *Strabo* tells us *Hypparchus* had Observed it at *Byzantium*; who first attempted the *Northern Ocean*, and Discovered the utmost *Thule*, in which *Cleomedes* coherently proves the *Summer Tropick*, to be the same with the *Polar*, or greatest of always apparent ones: and who (as from his Book, *de Oceano*, may be inferred) was exceedingly curious to find out what was the Position of *Heaven*, respective to the variety of Countries and *Climates*. But, not so soon to digress from the *Romans*; *Pliny* delivers, that in those first Times of *Rome* being a Common-wealth, the Invention of *Dials* was very Raw and Imperfect: for that they had only the Risings and Settings named, out of twelve Tables. That after some Years, they added the *Meridian*, and by the indication of a certain column, the last Hour: nor that neither, but only in clear Weather, even as long as till the first *Punic* War. Afterward they

they advanced so far, as to make one, on two *Sun-Dials*; but not with *Lines* exactly correspondent to the Hours, until about an Age after, when *Q. Marcus Philippus* ordered the Business more diligently and successfully. And, because the Hours of the Day remained yet uncertain in Dark and Cloudy Weather, *Nasica Scipio* began to divide the Hours of Day and Night equally by Water distilling from Vessel to Vessel, and called it *The Dial within Doors*, in the Year *Urbis conditæ DXCV*. And till then, saith *Pliny*, *Populi Romani indiscreta Lux fuit*. And thus much of *Hypparchus*, and some *Astronomers* betwixt him and the Prince of them all, *Ptolomy*.

Quintus Marcus Philippus, &c.  
Nasica Scipio, Romans.

And of him, so great is his Name, all we need to say, is only, that he was the very founder of the Art, or Science of *Astronomy*. For, though *Hypparchus* had indeed, as it were hewn out the Stones and Beams fit for so noble a Structure, and prepared good part of the Materials; yet was it *Ptolomy* alone who put them into Order and Form, and by adding many admirable Inventions of his Own, by infinite Labour and Cost, erected that so famous Building, worthily called Μεγάλη Σύνταξις, the great Co-ordination, Construction, or Composition: which consisting of no less than thirteen Books, contains all the Doctrine, that could then be advanced, concerning the *Sun*, *Moon*, and as well the Fixt, as Wandering *Stars*. And, albeit one Day teacheth another, and that (as Himself had truly foretold) there came others after Him, who saw good cause for the Castigation and Correction of many things delivered in that Work: yet, in the general, the Art he had instituted, remained Firm and Constant, and was afterwards imbraced, not only by the *Alexandrians*, but also by all the *Arabians*, *Latins* and others, who devoted themselves to the Service of *Urania*, ever since. For, that the Study of her *Celestial* Mysteries continued in great esteem and Veneration, at *Alexandria*, for some Ages after his Decease, may be undeniably attested, not only from hence (but among others) both *Theon*, and *Pappus*, who next re-named *Alexandrians*, were eminent therein; of which the one put forth eminent Commentaries upon *Ptolomies* Works, and the other, among sundry excellent Pieces, of which his sixth Book of *Mathematical Collections* is one, observed, that about four hundred Years from Christ, the Obliquity of the *Ecliptick* was not so great, as *Eratosthenes*, *Hypparchus* and *Ptolomy* had conceived: but neer upon the same we discover it to be in our Days

Artic. 10.  
Ptolomy, the true founder of Astronomy in one entire structure.

Who next re-named Alexandrians.

Days: we say that this is not the only Monument that is extant of the Flourishing of *Astronomy* at *Alexandria*; long after *Ptolomy* had given it so great a Reputation there; but there remains another as Fresh and lively, which is the Memorials of those *Patriarchs* of the *Alexandrine Church*, to whose Judgment the determination of that great dispute about the true Time of *Easter*, was thought fit to be wholly referred; as well by the *Nicene Council*, as by divers Learned *Bishops* afterward; and by *Holy Leo* himself, then *Pope*. Now, among these *Patriarchs* were *Theophilus*, *Cyrillus*, and *Proterius*, whose advice and directions were thought necessary, in regard that the Controversies raised about the Celebration of *Easter*, about the Time of the *Vernal Equinox*, about the *Full-Moon* next following, and about constituting certain constant Rules respective to them; could not be better composed, than by the definitive sentence of these Prelates, who Living at *Alexandria*, where *Astronomy* was in such Height, had the advantage of Others, in point of knowing those things which were requisite to the finding out of the Truth. But, of the *Arabians*, who in the Study of *Astronomy* succeeded the *Alexandrians*, and translated into their own Language, the Great Composition of *Ptolomy*, which they called *Almagestum*; the First, and most worthy to be remembered, was *Albategnius*, otherwise called *Mahometes Aractensis*, born of a Family of the *Dynastæ* of *Syria*; He about 800 Years after Christ, made divers *Celestial* Observations, partly at *Aracta*, and partly at *Antioch*: and found both that the *Apogee* of the *Sun*, since the Days of *Ptolomy*, was advanced to the following *Signs*; and that the *Stars* did regress toward the *East*, one Degree, not in the space of a hundred Years, as *Ptolomy* also had designed; but of somewhat less than seventy: as also, that the *Obliquity* of the *Ecliptick*, according to *Pappus* his Theory, was less (*viz.* above 23 Degrees 35 Minutes) with many other particulars concerning as well the *Fixt-Stars*, as the *Planets*: whereupon he both Corrected *Ptolomy* in many things and composed new Tables, and wrote a Book intituled, *De Scientia Stellarum*. After him, within two or three Ages following, succeeded *Alphraganus*, *Arzachel*, *Almeon*, and other *Arabians*; among whom (as bring already tainted with that superstition which had corrupted the simplicity of *Astronomy*, with *Astrological* Fooleries) some certain *Jews*, as ambitiously affecting the glory of *Divination* as the others, intermixed themselves.

After

And long after,  
to Albategnius,  
then to

Alphraganus,  
and other Ara-  
bians.

After them, for a long time, the Worship of *Urania* lay neglected, nor did *Astronomy* receive any the least (considerable) advantage by Observators; till near about four hundred years since, *Alphonfus* King of *Castile* and *Leon*, being himself also toucht with the curiolity of *Astrological* predictions, and discovering that the Tables as well of *Ptolomy*, as *Albategnius* were not exactly agreeable with the *Cœlestial* motions; set himself to the composing of new ones; and to that purpose convoked as many *Arab* and *Jews* as were eminent in those Days for *Astron.* employing them about Observations necessary to so great a Work, and comparing with them those of their Predecessors, that so they might be the more exact in the performance of their task proposed. And very memorable it is, that (as hath been credibly reported) He spent four hundred thousand peeces of Gold on that undertaking: a munificence truly worthy the Heroick mind of so great a Prince, and which well deserves to be had in perpetual commemoration by all lovers of Learning: but somewhat unhappily employed, in respect the Persons set a Work were not so strict in studiously and constantly observing, as scrupulously computing, directing their calculations not so much to what themselves and others had really observed, as to certain traditional mysteries or Cabalistical dreams: that we may pass by their heedlessness, which Regiment. detecting, perceived, that they had mistaken the true places of the *Fixt Stars*, by very near two whole Deg. as accounting the numbers of *Ptolomy*, as if they had bin constituted by him from the beginning of the Years of Christ. Which considered, we have the less reason to wonder, if the Tables composed by them, called from the Kings name, the *Alphonfine*, and sometimes from the place, where they were made, the *Toletan Tables* (whence also He, who was President of that assembly of *Astron.* is said to have been one *Iaac Chanter* of the *Toletan Synagogue*) have been found, ever since the time of *K. Alphonfus*, to disagree with the Heavens, and to require the review and castigation of some new and more faithfull hands. Thence forward *Astron.* lay neglected, and almost buried in Oblivion (only *Thebitius* an *Arab* and *Prophalius* a *Jew*, observed in the mean time some small matters, about the motion of the *Fixt Stars*, and the *Obliquity* of the *Ecliptick*,) until about two hundred Years since, *Georgius Peurbacchius*, and *Joh. Regiomontanus*, his disciple, seemed to revive it. For these worthy men delivered it out of the double cloud of ignorance and vanity, which the *Arabians* and *Jews* had

M m

railed,

Article 11.  
Alphonfus K.  
of Castile; who  
made and nam-  
ed the Al-  
phonfine Ta-  
bles

After whom  
the Science lay  
neglected, till  
Georg. Peur-  
bacchius and  
Joh. Regio-  
montanus a-  
rose.

and again cultivated the same.

raised to the Observations of its Lustre; and kindled the Light thereof afresh in Germany: reducing *Ptolomy*, providing Instruments, and making not a few faithful Observations: though they were not so Happy, as to bring their design to that perfection they hoped and had proposed to themselves; both of them dying in the middle and Flower of their Age.

Articl.  
Then followed  
the most acute  
Nich. Copernicus, who re-  
covered the Do-  
ctrine of Pytha-  
goras, concern-  
ing the Earth's  
motion

Animated by their example, *Nicholaus Copernicus* (a *Bornussian* born, and Canon of the Cathedral-Church of *Warmes*, situate near *Fruemburgh*, in the same Country) about the beginning of the last Age, seriously addressed himself to the Illustration of *Astronomy*, and reviving the long neglected Systeme of the *World* excogitated by *Pythagoras*, he made many good Observations, in order to the composing of new Tables. But, forasmuch as he could not determine any thing concerning the *Fixt Stars*, besides their Promotion Eastward, which they appeared to have made since *Ptolomy's* time; he therefore composed some Canons of their motions, and those as exact as possibly he could: yet both those, and the *Prutenick Tables* that were built upon them were incorrespondent to the motions of the Heavens, though less incorrespondent than the *Alphonsine*. Nevertheless, the man is to be highly commended, both for his sublime perspicuity, and modesty, in that foreseeing his Canons would need correction, he was wont frequently to exhort and encourage that ingenious young man, *Georgius Joachimus Reticus*, deeply enamoured of the Beauties of *Astronomy*, to apply himself principally to the Restitution of the *Fixt Stars*, and chiefly of those, which were in the *Zodiack*, or near it, and with which the *Planets* might be most conveniently compared: Because, without their Restitution, it was impossible either to attain to the true Places of the *Planets*, or to achieve any thing of Moment or certainty, toward the Advance of *Astronomy*.

Articl. 13.  
And last of  
All, the noble  
*Tycho Brahe*,  
who out-did all  
the rest in dis-  
coveries and in-  
ventions.

And then at last enters that Noble Dane *Tycho Brahe*, upon the Theatre of *Astronomy*. Who (as he in the impluse of his Genius) was addicted to Beholding and noting the *Stars*, even almost as soon as he saw the light of them; was so much the more spurred on by that advice of *Copernicus*, published in the Works of *George Joachim* newly mentioned, by how much the more clearly he discerned the impossibility of determining the true and proper place of that famous *New Star* (appearing in the Constellation of *Cassiopea*, from the beginning of *Novemb.* in the Year *MDLXXII.* for above sixteen Months together) without the

the restitution of the *Fixt Stars* to theirs. For, He plainly perceived, that most, if not all the Errors, which had bin found in *Astronomy*, even from its first foundation or original, took their rise chiefly from hence, that the *Fixt Stars* really were not in those places, in which they were supposed to be by Observators; But some of them were much neerer, and others again as much farther off; and this, whether because *Hipparchus* in the beginning had not with due exactness consigned all the *Fixt Stars* to peculiar places, which indeed he had designed by the *Sextants* of Degrees (and truly it is very difficult at once to invent any thing of Moment, and perfect the invention) or whether because the Transcribers of *Ptolomy*, out of carelessness, or ignorance, had corrupted the Original Text in many places; or whether the Additions afterward made, in respect of the *Stars* progress to the following Signs, had occasioned any mistake and imperfection in that Theory; or whether by any other unhappy cause whatever. Now, in Order to this great Work, of Rectifying those fundamental Errors, it pleased Fate, that about the very same time, that truly generous and never enough commendable Prince *W. Landgrave* of *Hassia*, had zealously devoted his Mind and Industry to the same care, of restoring the *Fixt Stars* to their true mansions: but yet the honour he aimed at, was decreed only for the incomparable *Tycho*, who in an Heroical bravery of Soul, had now resolved with himself to enterprize no less than the Instauration of the whole Science of *Astronomy* from its very fundamental; and so to spare neither labour, nor cost (especially while he was so happy, as to have good part of his expences defraied by the liberal contributions of that Eminent *Mecenas*, *Frederick the II. King of Denmark*, who thereby Recorded his name in immortal Characters on the leaves of Fame) that should be necessary to the making all sorts of Observations requisite. As soon therefore as he had furnished himself with that *Astronomical* Colledge, or Tower for Observations, built by him in the Island of *Huenna*, to that purpose assigned him by the King, and furnished that Heavenly Cittadel by him called *Uranburg*, with store of exquisite and magnificent Instruments Mathematical, he begun (having provided himself of sundry learned and competent Coadjutors) exactly to observe the Altitude of the Pole, in that Place, by the *Circum-Polar Stars*. By which understanding likewise the Altitude of the

the *Equator*, he pointed out the *Equinoctial Points*, by the passing of the *Sun* through them: and attending besides to the middle parts of *Taurus* and *Leo*, he found out the *Apogee* of the *Sun*, and the *Eccentricity* of it, and deduced its Course from the point of the *Vernal Equinox*. Moreover, from *Venus*, in the Day time compared with the *Sun*, and in the Night with the *Fixed Stars*; he endeavoured to search out the *Right Ascensions*, and *Declinations* of the *Fixed Stars*: which the Ancients had performed, but fallaciously by using the *Moon*, not *Venus*, to that purpose. And his success was as exquisite as his care in this, that he constituted that Bright Star which is in the top of *Aries*, and ranged the chief of those in order along the *Zodiack*: and then advancing to enquire or rather find out the distances of the rest as well from them, as each from other, he defined both the *Right Ascensions* and *Declinations* of all; prescribed their several *Longitudes* and *Latitudes*, and added to the Catalogue of the Ancients about 200 other Stars, wholly by them omitted. Because the Ancients, Living in an *Horizon* much more *Southern*, had observed and set down neer upon 200 Stars, that are invisible in the *Danish Horizon*, which is highly *Northern*: and *Tycho* again collected about 200 more than they could discern; and as being somewhat small, he intermixed them among others of greater magnitude. Further, having in the mean space, alwaies observed the passings of all the *Planets* through the *Merid*, and their several distances from the chief *Fixed Stars* neerest to them, he laid such solid Foundations, as by them might be exactly known, not only the true places of each, but also their several Motions. So that he came very neer the height of his noble hopes of building the whole Theory of *Astronomy* anew from the very ground, and of erecting compleat and everlasting Tables for Calculation thereupon: but alas prevented by an immature death. He could not accomplish his design. It was very much, however, that he went so far, as to have recorded and bequeathed to Posterity such excellent Observations, by which *Kepler* was soon after enabled to compose an intire Theory, and make the Tables called the *Rudolphine*; and by which, and others afterward contriveable, whatever can be desired in these Tables, may be fully supplied and perfected. And this among the rest deserves singular commendations, that he left us the *Fixed Stars* re-installed in their true mansions: wherein he alone, in few Years Practice, performed and finished

nished that prodigiously great Work, which no man from the Days of *Hipparchus*, had either attempted, or in any measure Advanced.

I pass by many other admirable discoveries of his, as that he was the first who demonstrated all *Comets* to be carried freely through the *Ethereal Spaces*; that *Refractions* ought to be carefully considered and allowed for, and how; that he perceived that the *Latitude* of the *Moon* ought to be augmented by more than a *Quadrant* or fourth part, than had been conceived; that he almost demonstratively convinced the *Latitudes* of the *Fixed Stars* to be varied; that he excogitated an *Hypothesis*, which all those who cannot allow of the *Ptolomaical*, for fear to allow the *Copernican*, may well adhere to and defend: with many other things, as difficult in their invention, as excellent in their use. And observe only, how vastly he transcended all that went before him, in point of exactness and certainty. As for *Instruments Mathematical*, it is well known, He made such, as for the condition of their matter, for the Vastness of their magnitude, for the variety of Forms, for the care of their elaboration, for the preciseness of their divisions, and for the Facility in using, as the *World* had never the like before. Again, so prodigious was his and his Coadjutors subtilty, diligence, industry; that whereas the Observations of *Hipparchus*, *Ptolomy*, and all others before him had bin marked out only by the Sixth, or at most by the twelfth part of Degrees; he designed all his by the Sixtieth parts of Deg. called *Minutes*, or *Scruples*, and very often also by subdivisions of *Minutes*. So that we may well demand what comparison can be made betwixt that gross way found out by *Eratosthenes*, and approved and followed afterward by *Hipparchus* and *Ptolomy*, for the Observation of the *Obliquity* of the *Zodiack*, and that most Fine and exact one invented by *Tycho*? His being, by a division of the *Merid*, into 83 parts, and the Interval of the *Tropicks* deprehended to take up 11 of them, it appeared that the distance of one *Tropick* from the *Equator*, amounted to 5 of those parts and a half, or by a reduction of them again to Degrees of 23 Deg. 51 Min. and  $\frac{1}{2}$  parts, and theirs, being by an hollowed *Hemisphere* of Stone, with a *Gnomon* erected in the middle, as we have formerly described it; and to what Deg. of subtilty and exactness this way of commensuration could arrive, the meanest Novice in *Astronomy* may soon judge; That *Quadrant* likewise of *Ptolomy*, so much admired by  
ancient

ancient Authors; Pray How vastly short did it come of the perfection of the least that *Tycho* used? And the same may be said of his *Rules*; for, that those *Armillae*, set up by *Ptolomy* in the entrance of *Alexandria* had any thing in them comparable to those erected by *Tycho* in his *Uraniburg*, cannot in the least measure be argued from the other Instruments then in use. It is not necessary, we should here again review those machinements, or Engines, which the old *Egyptians* and *Babylonians* made use of, either in discerning the Signs of the *Zodiac*, or taking the Diameter of the Sun: or those, which *Aristarchus* and *Archimedes* used, for commensurating the same Diameter. Only we cannot but wonder, by the way, how *Aristarchus*, having aimed so near the white of truth, in the matter of the Sun's Diameter, and determining it to be the 720th part of the Circle, or half a Degree; as is delivered by *Archimedes*, should yet err so widely in his book of *Magnitudes* and *Distances*, as to make the Diameter of the Moon (which in truth is very near as great as that of the Sun) to be the 180th part of the Circle, or 2 Deg. when he called it the Fifteenth part of a Sign; which mistake of his was long since taken notice of by *Pappus*. Nor is there any necessity, why we should survey those Instruments, that *Albategnius*, *Purbacchius*, *Reigiomontanus*, *Copernicus*, and other more modern *Astron.* used: considering, that besides the *Rules* made by *Reigiomontanus* (which *Bernardus Waltherus*, his Disciple, preserved, and had recourse to, in his Observations of the Sun's Altitude) they came so short of the least of *Tychoes*, in point of exact reasoning, and amplitude, that they deserve rather to be perpetually forgotten, than remembered to competition. However it is seriously to be wished, that the Observations made by those incomparable Instruments of His, may ly no longer concealed from the World (for by singular Providence they have been hitherto preserved, as *Gassendus* attesteth, in the life of *Tycho*) but soon be brought to Light. And this as well for sundry weighty Considerations there alledged by *Gass.* as for this, that not all the Stars, of which *Tycho* hath given a copious Catalogue in his *Prognymasmata*, may be found reduced to congruous Calculation (in as much as they do not exactly correspond with the Heavens) and that various Catalogues have been pretended from the same, which are very much different each from other: for all the difficulties hereupon depending may soon be removed, and all mistakes rectified, by having recourse to the

the Fountain, or Original observations, which will clearly declare what hath been already corruptly deduced, and what may be at length carefully and demonstratively deduced from them.

And, in the mean while, if *Hipparchus* his memory be so highly and (indeed) justly precious among learned men, for his great merits in excogitating and framing Instruments, whereby to take the dimensions, distances, motions &c. of Heavenly bodies: certainly, that of our *Tycho* ought to be as highly esteemed by us and all Posterity; since he alone, for so many Ages together was found, that durst not only imitate him in those sublime inventions; but so imitate, as very much to exceed him. For my part, truly; since *Hipparchus* may rightfully be called *Atlas the Second*: I shall do but justice to name *Tycho, Hercules the Second*, who relieving his Predecessor, long languishing and ready to faint under so prodigious a burden; which doubtless was the Reason, why *Kepler* called him, the *Modern Hipparchus*.

And thus have we in a short Relation, rehearsed to you, what we could gather together, concerning the Original, Progress, and Advance of *Astronomy*, from the highest of times, of which there remain any Authentick memorials, down to the decease of *Tycho Brahe*, the Noble and the Great. As for what Additions this excellent Science hath received, by the industry of *Astronomers* in this present Age, by the help of the *Telescope*, whose Invention may seem to have been unhappily deferred too long, as being deferred till some Years after *Tycho's* death: they may be easily summed up. For all that our Days can justly challenge the honour of discovering, is, 1.) the spots in the Sun: 2.) the inequality of the superficies of the Moon: 3.) *Venus* shifting her appearances, as doth the Moon: 4.) *Mercury* and *Jupiter* in some Proportion, doing the like: 5.) *Jupiter* with a kind of a bound about him, and guarded with four lesser Stars as Attendants: 6.) *Saturn* triple-bodied: 7.) the *Gallaxy* fully beset with small Stars: and 8.) divers pale assemblies of small Stars seeming to be only little white clouds in the *Welkin*, with some other particulars lately remarked. Now if you please to add this to the former summary: you have the whole (though brief) Story of *Astronomy*, from its very infancy to that augmented state it now hath attained: I wish I might have said to its *Full growth and Perfection*. But, alas! that is reserved for Posterity.

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